APPENDIX A: Engineering

LAKE WORTH INLET

Palm Beach Harbor

NAVIGATION STUDY FOR
LAKE WORTH INLET, FLORIDA

INTEGRATED FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT

APPENDIX A
ENGINEERING

NAVIGATION STUDY FOR
LAKE WORTH INLET, FLORIDA

DRAFT INTEGRATED FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT

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ENGINEERING

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A. INTRODUCTION

1. General. This appendix presents the discussion of applicable design considerations and construction methods utilized to adequately address the project requirements and to establish a basis for the cost estimates. General requirements for real estate and operation and maintenance are also presented.

2. Recommended Plan. The recommended plan incorporates National Economic Development (NED) improvements to the Federal navigation project at Lake Worth Inlet, Florida. These improvements would include the addition of a new channel flare on the south side of the Entrance Channel, a widening of the Entrance Channel by either 40' or 60' to the north, widening of the Inner Harbor Cuts 1 and 2 to provide for a minimum channel width of 450', a 150' expansion of the Southern (Main) Turning Basin to the south, and an expansion of the Southern (Main) Turning Basin on the north side to remove a notch currently encroaching into the basin. The channel would be deepened to a project depth of 39 feet Mean Lower Low Water (MLLW) for the Inner Harbor and 41 feet MLLW for the Entrance Channel plus applicable allowances and overdepths discussed in this Appendix. Refer to Plate 2 for a complete description of the NED project improvement features.

In addition to the navigation project improvements described above that are necessary to facilitate the safe and efficient navigation of the design vessel, there are other features needed to support the project. These features include North Jetty stabilization, reconfiguration of the Advance Maintenance Zones, reconfiguration of the Settling Basin, Seagrass Mitigation Area construction, and Hardbottom Mitigation Area construction as detailed in this Appendix and other areas of the Feasibility Study Report.

A discussion of the plan formulation involved in the selection of the Recommended Plan is presented in the main portion of this report. All soundings presented in this report are at MLLW based on the latest tidal epoch available from NOAA and the project is located geospatially in the North American Datum of 1983 (NAD83).

B. HYDROLOGY AND HYDRAULICS

3. General. A project location and vicinity map showing the features described below is provided on Plate 1. The currents and water surface elevations in Palm Beach Harbor are subject to tide, the effects of winds, upland drainage, and variations in barometric pressure. These factors serve as boundary conditions for the hydraulic forces influencing the smaller scale limits of this study area. The hydrodynamic model investigations conducted for this feasibility study are presented in an Attachment to this Appendix. Attachment A (Hydrodynamic Modeling) includes two dimensional model descriptions and results that were conducted in support of alternative evaluations and an assessment of channel modification impacts on bay circulation (i.e., currents), channel shoaling and storm surge.

4. Tides. The astronomical tide is the most important factor driving the circulation of water within the Harbor and in the variation of water elevations. The tide is semi-diurnal where two high waters and two low waters generally occur in a tidal day. The mean tide range is 2.72 ft and the spring tide range is 3.26 ft.

5. Currents. Tidal currents in the Palm Beach Harbor entrance channel are strong. The maximum currents occur in the entrance channel where maximum flood currents of 6.0 feet per second (3.6 knots) are experienced and the maximum ebb velocity is 4.0 feet per second (2.4 knots). Average flood and ebb velocities in the entrance channel are 3 feet per second (1.75 knots) and 2 feet per second (1.25 knots) respectively. At the Inner channel the average flood and ebb velocities are 2.7 feet per second (1.6 knots) and 2.5 feet per second (1.5 knots). In the Intracoastal Waterway (IWW) at Peanut Island the average flood and ebb velocities are both 1.3 feet per second (0.75 knots).

6. Sea Level Rise. The geologic record of historical sea level variations indicates that both increases and decreases in global sea level have occurred. Both global cooling and warming contribute to sea level change. The National Ocean Service (NOS) has compiled long term records of measured water surface elevations along the Atlantic coast. This data is the basis for projecting future relative sea level rise at Palm Beach Harbor.

Relative sea level (RSL) refers to local elevation of the sea with respect to land, including the lowering or rising of land through geologic processes such as subsidence and glacial rebound. It is anticipated that sea level will rise within the next 100 years. To incorporate the direct and indirect physical effects of projected future sea-level change on design, construction, operation, and maintenance of coastal projects, the U.S. Army Corps of Engineers (USACE) has provided guidance in the form an Engineering Circular, EC 1165-2-212 (USACE, 2011).

EC 1165-2-212 provides both a methodology and a procedure for determining a range of sea level rise estimates based on the local historic sea level rise rate, the construction (base) year of the project, and the design life of the project. Three estimates are required by the guidance, a baseline estimate representing the minimum expected sea level change, an intermediate estimate, and a high estimate representing the maximum expected sea level change. Following procedures outlined in EC 1165-2-212, Appendix B, baseline, intermediate, and high sea level rise values were estimated over the life of the project. Based on historical sea level measurements taken from NOS gage 8723170 at Miami Beach, Florida, the historic sea level rise rate was determined to be 2.39 mm/year (0.0078 ft/year) (http://tidesandcurrents.noaa.gov/sltrends/index.shtml); the project base year was specified as 2017; and the project life was projected to be 50 years. Figure F-1 shows the three levels of projected future sea level rise for the life of the project. From these curves, the baseline, intermediate, and high sea level rise values at the end of the 50 year life of the project were projected to be 0.39, 0.89 ft, and 2.47 ft, respectively.

The total regional sea level rise predicted by the three scenarios (baseline, intermediate, and high) will not have a significant impact to the performance of the Palm Beach Harbor project. Potential impacts of rising sea level include overtopping of waterside structures, increased shoreline erosion, and flooding of low lying areas. A positive potential impact of sea level rise on the project is a reduction in required maintenance due to increased depth in the channel.

In general, regional sea level rise (baseline, intermediate, and high) will not affect the function of the project alternatives or the overall safety of the design vessel. While there is expected to be a small increase in tidal surge and penetration for all three scenarios, the structural aspects of the project will be either unaffected or can be easily adapted to accommodate the change.

7. Storm Surge. An analysis was conducted to determine if there would be an impact to storm surge water levels at the project site due to proposed deepening of the Palm Beach Harbor Federal Navigation Project. A two-dimensional hydrodynamic model was used to simulate a 100-year return interval total storm tide event on two different model bathymetries representing the existing condition bathymetry and a future bathymetry representing the Federal project with all proposed deepening and widening of the channels and Harbor. The results of these numerical simulations were analyzed to determine any potential changes to total storm tide that might result from the proposed modifications to Palm Beach Harbor. Differences between with and without project water-level elevations in the vicinity of the harbor were less than 0.1 m. Therefore no significant impact of project alternative to storm surge is anticipated.

8. Shoaling. In order to assess changes to shoaling patterns and volumes resulting from proposed channel modifications, a two-dimensional hydrodynamic model was developed that is capable of simulating complex coupled wave, current and sediment transport processes. The settling basin to the north of the entrance channel is an integral part of the sediment transport dynamics in the entrance channel area. The settling basin has been expanded several times to reduce shoaling in the entrance channel. Included in this investigation is an evaluation of the present and proposed settling basin as well as recommended modification for greater reduction of shoaling in the navigation channel.

Future maintenance requirements based on model results and historical shoaling volumes for the Inner Harbor, which include the Inner Channel and Turning Basins is estimated to be a 9.5% increase (1636 cy/yr) of the historical volume (17,224 cy/yr) (See Attachment A, Hydrodynamic Modeling, Table ST1) which corresponds to the increase in project footprint for the Southern (Main) Turning Basin. The Inner Channel (Cuts 1 and 2) does not currently require any maintenance due to tidal flushing and this condition is not anticipated to change based on hydrodynamic modeling results. Since the Turning Basins are not dredged as often as the Entrance Channel and Settling Basin, it should not affect the dredging frequency.

In order to accommodate shoaling that occurs in the selected project alternative channel depth, advanced maintenance zones were established. Future maintenance requirements based on model results for the Entrance Channel (including Advance Maintenance) predict a shoaling rate of 33,000 cy/yr and for the Settling Basins a rate of 68,000 cy/yr. That is similar to the current historically measured shoaling rate; however, a significant portion of the volume is trapped in the settling basin rather than the channel. For purposes of consistency, the predicted shoaling value for the Entrance Channel and Settling Basin are combined and rounded to 100,000 cy/yr. The dredge cycle for the proposed project is once every 2 years (it is once per year currently) as the new capacity of these optimized features prevents the project from shoaling significantly above the project depth within the channel. Therefore, the total maintenance volume estimate is 200,000 cy/2 yr. This is based on an average basis, depending upon storm activity or lack thereof, where there may be periods when dredging is required annually and others where dredging is not required until 3 years after the previous event. Based on experience from other construction deepening projects completed by the Jacksonville District, it is anticipated that the first maintenance event for the project will not be needed until the third year following initial construction. This is primarily due to the incorporation of required overdepth in the initial construction dredging. The overall estimate is 24 Maintenance Dredging events over the 50-year project life.

C. GEOTECHNICAL

9. General. The geotechnical investigations and the geologic conditions encountered within the scope of study are presented in an Attachment to this Appendix. Attachment C (Geotechnical) includes core boring locations and associated representative data. Additional Investigations will be required to enhance the existing data to bring it to Plans and Specification standards.

10. Existing Jetty Stability. A slope stability analysis was performed using SLOPE/W within the GeoStudio 2004 (Version 6.22) suite to determine the stability of the existing channel slopes in the vicinity of both the north and south jetty. Slope geometry was based on information provided by a survey performed in 2002. Since the exact foundation elevations for both the north and south jetties are unknown, as described in Attachment C, it was conservatively assumed that between elevation -23.5 NAVD88 and -30.0 NAVD88 the foundation material consists of high blow count sand and not jetty stone. Engineering Manual (EM) 1110-2-1902 "Slope Stability" (dated 2003) was the guidance used, with Table 3-1 requiring a long-term minimum factory of safety of 1.5. The worst-case (i.e., steepest) slope scenarios were analyzed. The results of the slope stability analysis indicated that between an isolated area, from STA 42+50 to STA 45+50, for which the 2002 survey showed existing side slopes steeper than one foot vertical to two feet horizontal (1V:2H), the south jetty (in its current state) has an inadequate factor of safety of 1.05. The same 2002 survey indicated no specific areas of concern for the north jetty, and analysis determined that this jetty has an adequate factor of safety of 1.87 in its current state. It should be noted that the final plans and specifications will be referenced in the project datum, MLLW. However, this geotechnical analysis was performed using NAVD88 as the datum since the 2002 survey data, for which the slope stability model geometries were based on, was referenced to NAVD88.

11. Jetty Stability with Recommended Plan. A slope stability analysis was performed to determine if the proposed dredge design template would impact the stability of the existing jetties located to the north and south of the proposed project.

South Jetty: Analysis was performed at locations where the design template intercepted the existing slope closest to the jetties. The stability of the south jetty remained unaffected, as shown in Figure 2 of Attachment C, since the design template terminates approximately 50 feet north (i.e. 50 foot buffer) of the toe of the existing slope. As stated above, the south jetty in its current state has an inadequate factor of safety based on conservative assumptions outlined in Attachment C. No jetty stabilization features will be implemented since the proposed dredge design template will not impact its stability in its current state, and would therefore be outside the scope of this project.
North Jetty: Due to several unknown factors detailed in Attachment C, a 15 foot horizontal bench (i.e., 15 foot buffer) was established in the design, beyond the channel side toe of the north jetty, as an added safety measure. At locations along the north jetty from STA 39+00 to 44+00, where the channel template encroached into the 15 foot buffer, the channel template was adjusted to negate the impact, or jetty stabilization measures were incorporated into design to stabilize the jetty. The template was adjusted by eliminating the advanced maintenance in the areas where the design template width extends beyond the existing template (i.e., closer to the jetty). However, an abbreviated area, from approximately STA 38+75 to 40+75, still required the advance maintenance area due to the vast amount of sand that has been shown to shoal around the north jetty head. The preliminary design of a jetty stabilization feature consists of sheet pile wall placed near the jetty toe in this area which still required advanced maintenance. Details of the preliminary analysis including existing conditions, with project conditions, the methods used, and results are presented in Attachment C. Based on this preliminary evaluation, a PZC-26 sheet, extending below the surveyed

bottom to an elevation -60.0 NAVD88 is currently recommended to stabilize the existing jetty. Horizontal extents of this feature are currently anticipated to extend parallel to the jetty toe from approximately STA 38+75 to 40+75. Design details such as exact location, width, depth (minimum tip elevation), and sheet pile type will need to be refined during the PED phase using data resulting from the upcoming geotechnical exploration, scour analysis, and other design factors.

12. Channel Side Slope Selection. The available Geotechnical data indicates that the subsurface conditions for the areas west of STA 45+00 are composed of either thinly bedded and moderately hard limestone and sandstone, or layers of sand, silty sand, limestone and sandstone; therefore, side slopes of 1 foot vertical to 1 foot horizontal (1V:1H) were preliminarily selected for these areas. As an exception in these areas, the southern expansion of the Main Turning Basin will have a tiered system, with 1 foot vertical to 3 feet horizontal (1V:3H) slopes above EL 30.0 MLLW, and 1 foot vertical to 1 foot horizontal (1V:1H) below EL 30.0 MLLW. East of STA 45+00, borings indicate sand and silty sand; therefore, all slopes shall be no steeper than 1 foot vertical to 3 feet horizontal (1V:3H). The side slopes were derived from historical project information, an analysis of the materials to be dredged and existing channel bathymetry. Additional information is provided in Section D below.

D. DESIGN AND CONSTRUCTION

13. General. A project location map is shown on Plate 1. The proposed project plan of improvements to the Federal navigation channel is shown on Plates 2 through 8, and typical sections of the channel are provided on Plates 13 through 18.

14. Side Slopes. For estimating purposes, the average side slope for the proposed excavation was determined to be 1 vertical on 3 horizontal (1V:3H) for the Entrance Channel Station 0+00 to Station 45+00 and 1 vertical on 1 horizontal (1V:1H) for the remainder of the project with the exception of the southern expansion of the Main Turning Basin which utilizes a combined slope of 1V:1H below elevation -30' MLLW and 1V:3H above -30' MLLW, refer to Plates 11 through 18 for details.

15. Overdepths. An additional 2-foot of required overdepth and 1-foot of allowable overdepth are included in the estimated excavation quantities. The required overdepth would be necessary to facilitate future maintenance of the channel due to the existence of consolidated material at project depth. The allowable overdepth would be included to provide for inaccuracies in the dredging process in accordance with ER-1130-2-520, Navigation and Dredging Operations and Maintenance Policies.

16. Advance Maintenance and Settling Basin Reconfiguration. The existing project incorporates both advance maintenance and settling basin features as shown on Plate 9. In order to optimize the performance of these features, hydrodynamic modeling was conducted and the resulting reconfiguration of the advance maintenance zones and settling basins are shown on Plate 10. The primary purpose of the reconfigured features is to trap sediment outside of the Federal navigation channel thus preventing shoaling of the channel and decreasing the frequency of maintenance dredging needed to keep the channel open and free from navigation restrictions.

17. North Jetty Stabilization. The preliminary slope stability analysis determined that the North Jetty will require stabilization features to ensure jetty stability once the proposed project has been constructed. The stability of a portion of the North Jetty is affected by the 40-foot widening of the

Entrance Channel to the north coupled with the need to incorporate advance maintenance zone C (AMZ-C) at the tip of the jetty to capture the littoral sand transport. The stabilization feature, sheet pile, was developed using engineering judgment based on the limited core boring data available and historical records for the jetty construction. Refer to Plates 4, 10, and 15 for details regarding the location and length of the proposed sheet pile. A complete and thorough analysis of the subsurface conditions, design of the stabilization feature, as well as any new information pertaining to the existing jetty itself will be required during the PED phase based on the results of the new geotechnical exploration program.

18. Disposal Areas. It is anticipated that all of the material to be excavated from the Entrance Channel from Station 18+00 (project beginning) up to Station 45+00 would be placed in the nearshore disposal area immediately offshore of the existing permitted beach disposal area located south of the inlet (R-76 to R-79, below the MHW line, landward of the -17 ft contour). Currently, some real estate easements are not available for the existing beach disposal area (R-76 to R-79, above the MHW line). However, if they become available at the time of construction then beach quality material would be placed to capacity in the beach disposal area prior to placement in the nearshore disposal area. Additionally the O&M program, separate from this project, is working on permitting the expanded beach disposal area. If the permit for the expanded beach disposal area is obtained prior to construction of this project, it could be considered for this project. Requirements involved with the usage of the existing beach disposal area and procurement of a proposed expanded beach disposal area for O&M material will be handled under the O&M program. All material from the remainder of the project (Entrance Channel Station 45+00 to end, Cut-1, Cut-2, Southern Turning Basin, and reconfigured Settling Basins) would either be placed in the Palm Beach Ocean Dredged Material Disposal Site (ODMDS) or in the required mitigation sites for seagrass or hardbottom habitat. If, based on additional geotechnical investigations, it is determined that beach quality material exists in sufficient quantity and can be feasibly recovered from these areas of the project, then this material could be placed in the Beach or Nearshore Placement Areas rather than the ODMDS. Refer to Plates 19 and 20 for the Beach and Nearshore Placement Areas plan and typical sections, Plate 23 for the Palm Beach ODMDS site plan, and Plates 21 and 22 for mitigation site locations and conceptual plan and typical sections.

Opportunities for additional beneficial use of dredged material exist in the project vicinity such as the filling of anoxic deepwater holes in the Lake Worth Inlet Lagoon, creation of hardbottom habitat, creation of habitat for submerged aquatic vegetation such as seagrasses and/or placement of beach quality material at the MidTown Beach Placement Area. It is not anticipated that the alternative forms of disposal of the dredged material from this project for purposes of beneficial use will result in any cost savings to the project; however, if cost increases are considered small or if there is local interest in paying for any cost difference, these alternatives could be further developed and incorporated into the project.

19. Construction Procedure. For cost estimating purposes, it is anticipated that a mechanical dredge (barge mounted backhoe) and scow barges would be used for construction of the Inner Harbor and Settling Basin and a hydraulic cutter-suction dredge would be utilized to dredge the Entrance Channel where beach quality material exists. Mechanical dredging would be utilized for the portions of the project that involve disposal at the ODMDS or mitigation sites and the hydraulic dredge is utilized where beach quality material exists and disposal occurs by pumping material directly into the nearshore placement area. Screening of the material being placed into the nearshore will be required in order to remove all rock fragments greater than approximately 2 inches in diameter.

E. RELOCATIONS

20. General. The project sponsor would be required to assume the costs of all relocations and alterations. An investigation into possible utility relocations has been conducted and based on its results there are no relocations anticipated. There is an existing pipeline under the Entrance Channel to service the Sand Transfer Plant that is below the depth of the proposed project as shown on Plate 5.

F. OPERATION AND MAINTENANCE

21. General. The Federal Government currently maintains the existing project annually. The Federal Government would be responsible for operation and maintenance of the improvements to the Federal Navigation project proposed in this report upon completion of the construction contract. The local sponsor, Port of Palm Beach, would be responsible for the costs of the construction and maintenance dredging of the Port Slip 3. The Port of Palm Beach is also responsible for the costs of infrastructure improvement of the port facilities that are scheduled to be completed in advance of the authorization of the Federal navigation improvements.

22. Estimated Annual Cost. Based on the hydrodynamic model results it is shown that the proposed project improvements result in a relatively small increase in maintenance volumes in the Inner Channels and Entrance Channel. However, with the implementation of the reconfigured Settling Basin and Advance Maintenance features it is anticipated that the frequency of maintenance dredging events can be decreased from an annual basis to a biannual basis. For the project life of 50 years this optimization will result in an overall reduction of maintenance dredging costs by reducing the fixed costs of dredge mobilization and the administration of 24 rather 50 contracts. Since the beach/nearshore disposal area south of the inlet continually erodes it provides adequate capacity for regular maintenance material and therefore it is not necessary to develop a long term management plan for the new project that is any different than what is being practiced for the existing project. Requirements involved with the usage of the existing beach disposal area and procurement of a proposed expanded beach disposal area will be handled under the O&M program as it currently is for this project. Refer to the Socio-Economic Appendix C for further details regarding the estimated maintenance costs for the project.

23. Navigation Aids. The U.S. Coast Guard (USCG) would be responsible for providing and maintaining navigation aids. Since there will only be a slight realignment of the Entrance Channel centerline (20' northerly shift), the Palm Beach Harbor Pilots have requested that there be no relocation of the Range Markers from their current positions. The channel widening and turning basin expansion will necessitate the need to relocate certain buoys; however, this relocation is considered minor and incidental by the USCG and therefore there will be no cost to the project for their physical relocation. A relatively small amount of cost is identified in the MCACES estimate to cover miscellaneous administrative costs for coordination with the USCG during and post construction.

G. QUANTITIES AND COST ESTIMATES

24. Summary of Quantities. A summary of the major construction items are presented in Table T-1 and details of the areas to be dredged are provided in Tables T-2 and T-3 below.

25. Summary of Costs. The estimates of first cost for construction of the NED Plan were prepared using MCACES software and are presented in the Cost Appendix. The estimate includes a narrative, a summary cost, and a detailed cost showing quantity, unit cost, and the amount for contingencies for each cost item. The costs of the non-construction features of the project are also included in the cost estimate.

The costs have been prepared for an effective date of Fiscal Year 2013 (FY13).

H. SHIP SIMULATION STUDY

26. Discussion. The preliminary engineering design for improvements to deep draft navigation features at Lake Worth Inlet and Palm Beach Harbor was completed in May of 2011. Optimization and testing of the design was scheduled for the third quarter of that year. The Full-Bridge, 360 degree Simulator at STAR Center, in Dania, Florida was selected for the simulation work, and testing by the Professional Harbor Pilots from the Port of Palm Beach. STAR Center was the preferred site for the ship simulation study, based on the fact that they maintain a validated simulation model of Palm Beach Harbor, that could be modified to optimize and test the new engineering design, in conformance with engineering quality requirements mandated by the Corps. The model had been developed earlier, for a study conducted by the Port, of their planned cruise terminal expansion and associated deep draft facilities. A formal proposal to conduct the study at STAR Center was negotiated at the Corps of Engineers in Jacksonville, in July of 2011. Engineering oversight for the work at STAR Center was provided by Dennis W. Webb, PE, Group Leader, Deep Draft Navigation Group, US Army Corps of Engineers, Engineering Research and Development Center, Vicksburg, Mississippi, and, Philip T. Sylvester, hydraulic engineer ship simulation technical expert from the Corps of Engineers, Jacksonville District.

Validation of the Lake Worth Inlet / Palm Beach Harbor simulation model was accomplished during the first day of simulations that were completed over the two week period, September 18 to October 2, 2011. Validation is a test of the water currents used in the model. It is a confirmation of the channel layout and navigation aid placement. Validation is a check of the maneuverability and ship handling characteristics, in real time, that each design vessel demonstrates, in the exact visual space displayed by the simulator, as the engineering design of the harbor, properly and correctly referenced and fixed, in the overall larger testing domain. The water currents examined and verified were provided through hydrodynamic modeling of the harbor, by the Corps Coastal Hydraulics group in Jacksonville. Validation is an essential component of the study, performed by the licensed professional harbor pilots from Palm Beach Harbor, that certifies the usefulness and correctness of the simulation model as an engineering tool properly conceived and developed to optimize and test the proposed engineering design.

STAR Center completed their Final Report of Lake Worth Feasibility Study in December of 2011. The report is a comprehensive discussion of the simulator facility, and the activities associated with ship simulation testing of the proposed engineering design for Lake Worth Inlet /Palm Beach Harbor.

Simulation testing matrix, simulation scenario track plots, and harbor pilot post test run evaluations are included in it appendices. The report also includes observations and recommendations with regard to engineering design in the context of navigation usefulness, relevance, and safety. The Report is provided as Attachment B for review and reference. The track plots and comment sheets from the Report are considered to be proprietary intellectual information by the Port of Palm Beach Pilots. A copy of this information is held in confidence by ERDC and the District Office (Philip Sylvester 904-232-1142).

27. Optimization. The Professional Harbor Pilots from Palm Beach Harbor have been on the engineering study team from the very beginning of design development for their facility. The Corps of Engineers in Jacksonville always engages the local harbor pilot group and cultivates a close professional working partnership with them, to learn their site, to understand their problem, and formulate a possible solution that will improve their efficiency and safety. Palm Beach Harbor Pilots' Association has been an active, cooperative, and highly valued member of the engineering design team. Their group has provided many hours of work to develop and shape the engineering design for their facility. This work included direct visits of the Corps design team to the Pilots' office to work hand in hand on refinements of the channel in order to ensure that no mistakes or misunderstandings could occur with the development of the final plan. They have provided a written statement of support for the design alternative selected during simulations, and worked with the Jacksonville engineering design team to iterate that tested concept into its current, "perfected", buildable form. Their letter of support is included in the Attachment B for review and reference.

28. Agency Technical Review. The control of quality is an essential component of the engineering mission at the Jacksonville District. The ship simulation study conducted at STAR Center – its concept, development, execution, oversight, and conclusions – has been successfully examined for quality and correctness, within the formal framework of Agency Technical Review. All comments have been evaluated, addressed, and back-checked to the satisfaction of the assigned review team. A copy of the ATR comment report has been added to Attachment B.

Figure F-1. Projected Future Sea Level Rise at Palm Beach Harbor

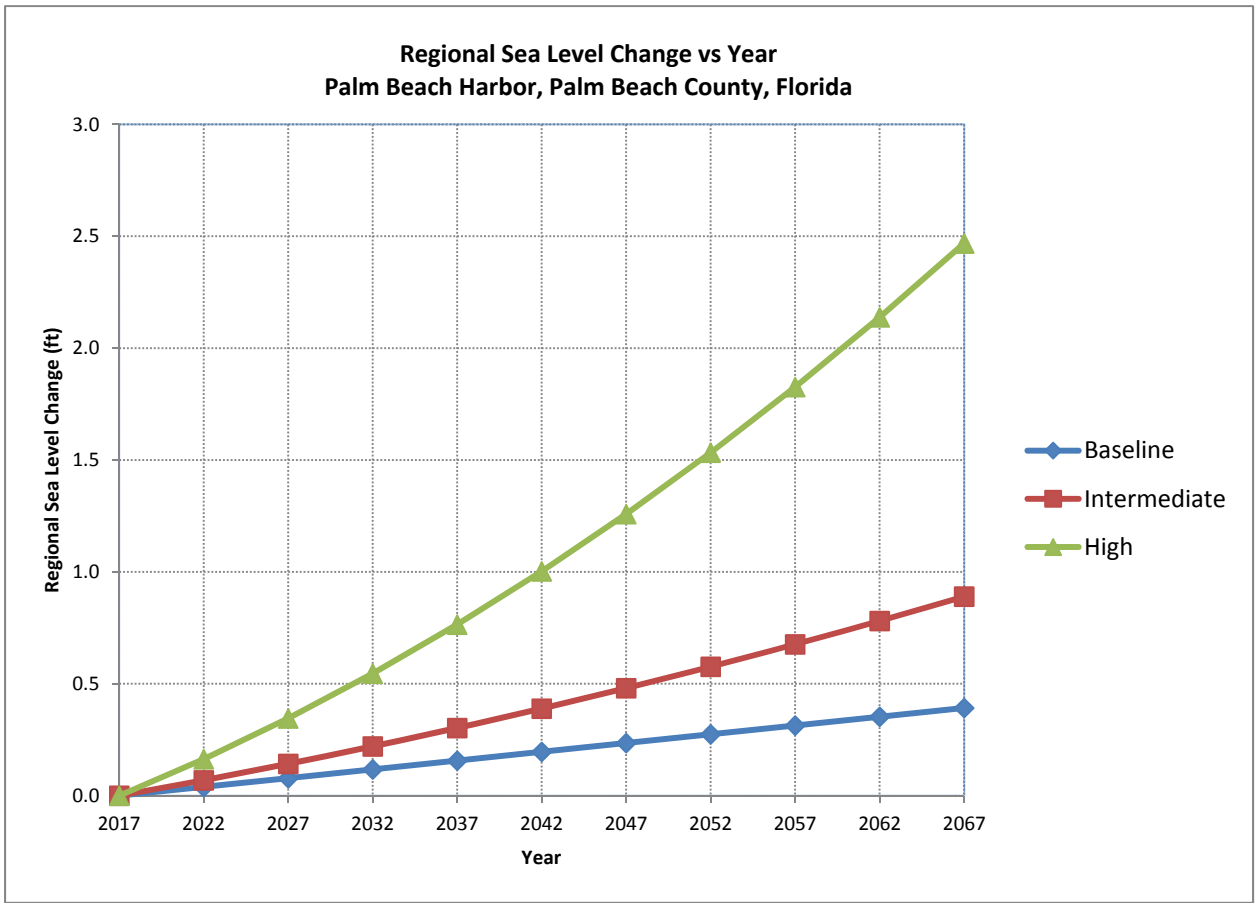


Table T-1 Summary of Construction Quantities for Recommended Plan

Item	Quantity	Notes
Dredging Volumes (Federal)		
Entrance Channel	285,404 cubic yards	Disposal in nearshore
Entrance Channel	145,767 cubic yards	Disposal in ODMDS
Inner Harbor	897,639 cubic yards	Disposal in ODMDS
Inner Harbor	125,440 cubic yards	Disposal in Seagrass Mitigation Area
Advance Maintenance	173,500 cubic yards	Disposal in nearshore
Advance Maintenance	12,000 cubic yards	Disposal in ODMDS
Settling Basin	258,000 cubic yards	Disposal in ODMDS
North Jetty Stabilization		
PZC26 Sheet Pile	200 LF, pile length = 63 feet	
Seagrass Mitigation Construction		
Dredge, Transport and Place Fill	88,315 cubic yards*	Place in Site S-10
Dredge, Transport and Place Select Fill	37,125 cubic yards*	Place in Site S-10
Hardbottom Mitigation Construction		
Provide and place limestone boulders	25,100 cubic yards	Place in Site H-3

*It is anticipated that approximately 125,440 cy of material from the Inner Harbor will be used in the construction of the Seagrass Mitigation Area rather than be disposed in the ODMDS.

Table T-2 Summary of Dredge Areas and Haul Distances			
Dredge Area	Surface Area (sqft)	Distance to Nearshore (ft)	Distance to ODMDS (ft)
1	48000	4285	27163
2	480000	4153	27189
3	346746	3950	27237
4	52000	3390	28405
5	520000	3222	28430
6	166900	3012	28465
7	10555	2979	29150
8	80000	2786	29174
9	3150	2597	29201
10	1200	2884	29350
11	80000	2693	29374
12	78000	2666	30096
13	524495	2461	30119
14	385806	N/A	32332
15	1048763	N/A	32176
16	75813	N/A	34288
17	2340508	N/A	34977
18	535596	N/A	35822
4AMA	36000	3390	28405
4AMC	6000	3390	28405
5AMA	360000	3222	28430
5AMC	18750	3222	28430
6AMA	142420	3012	28465
5/8AMB	221250	2786	29174
11AMB	80000	2693	29374
SB1	266000	3770	28330
SB2	38000	3770	28530
SB3	78750	3965	28650

Table T-3 Summary of Dredging Volumes for Recommended Plan

Project Depth = 39 feet (Volumes include 2 feet required overdepth plus 1 foot allowable overdepth)
Supports unrestricted vessel movement at draft = 36 feet (3 feet Underkeel Clearance for Inner Harbor and 5 feet Underkeel Clearance for Entrance Channel)

Channel Area	Depth	Volume (cy)	Nearshore	ODMDS
1	44	6648	X	
2	44	65724	X	
3	44	69081	X	
4	44	40765	X	
4AMA	52	10700	X	
4AMC	52	1800	X	
5	44	45336	X	
5AMA	52	107000	X	
5AMC	52	5500	X	
6	44	43657	X	
6AMA	52	42500	X	
7	44	3281	X	
8	44	9577	X	
8AMB	48	6000	X	
9	44	1335	X	
10	44	5568		X
11	44	15663		X
11AMB	48	12000		X
12	44	40867		X
13	44	83669		X
14	42	228339		X
15	42	118469		X
16	42	66063		X
17	42	429989		X
18	42	180219		X
TOTALS		1639750	458904	1180846
Settling Basin Area				
SB1	52	167000		X
SB2	35	31000		X
SB3	27	60000		X
TOTALS		258000		258000

X=965,000
X=966,000
X=967,000
X=968,000
X=969,000
X=970,000
X=971,000
X=972,000
X=973,000
X=974,000
X=975,000

Y=889,000
Y=888,000
Y=887,000
Y=886,000
Y=885,000
Y=884,000
Y=883,000
Y=882,000

LAKE WORTH

PEANUT ISLAND

SINGER ISLAND

LAKE WORTH INLET

NED PROJECT EXPANSION

EXISTING PROJECT

APPROXIMATELY 4.4 NAUTICAL MILES TO CENTER OF ODMDS RELEASE ZONE

ENTRANCE CHANNEL

NORTHERN TURNING BASIN

CUT-1

CUT-2

SOUTHERN TURNING BASIN

SLIP 1

SLIP 2

SLIP 3

PORT OF PALM BEACH

R-76

500'

STA. 18+00 E.C.

TOWN OF PALM BEACH

R-77

R-78

R-79

R-81

NEARSHORE DISPOSAL AREA

EXISTING BEACH DISPOSAL AREA (APPROX. 2900')

PROPOSED EXPANDED BEACH DISPOSAL AREA (APPROX. 2000')

ATLANTIC OCEAN

LWI-60

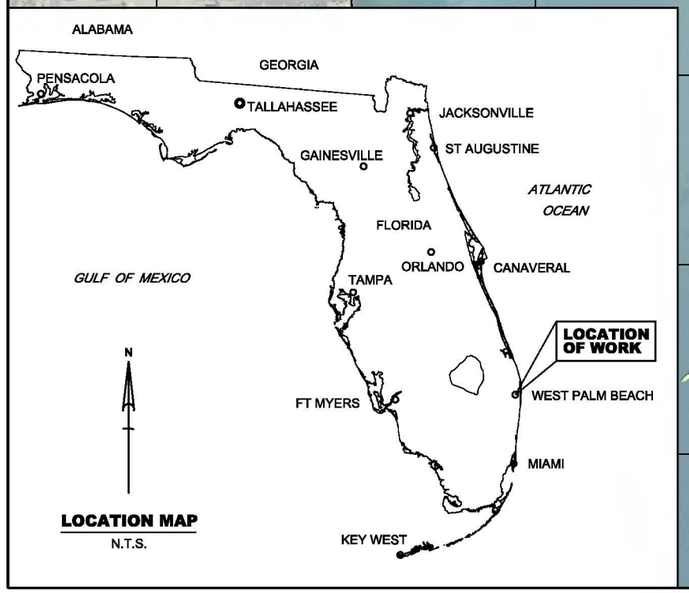
EXISTING NAVIGATION PROJECT

NAVIGATION PROJECT EXPANSION

VICINITY MAP

GRAPHIC SCALE

800' 0 800'



LOCATION MAP
N.T.S.

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Plot scale:
Dated: SEPTEMBER 2012
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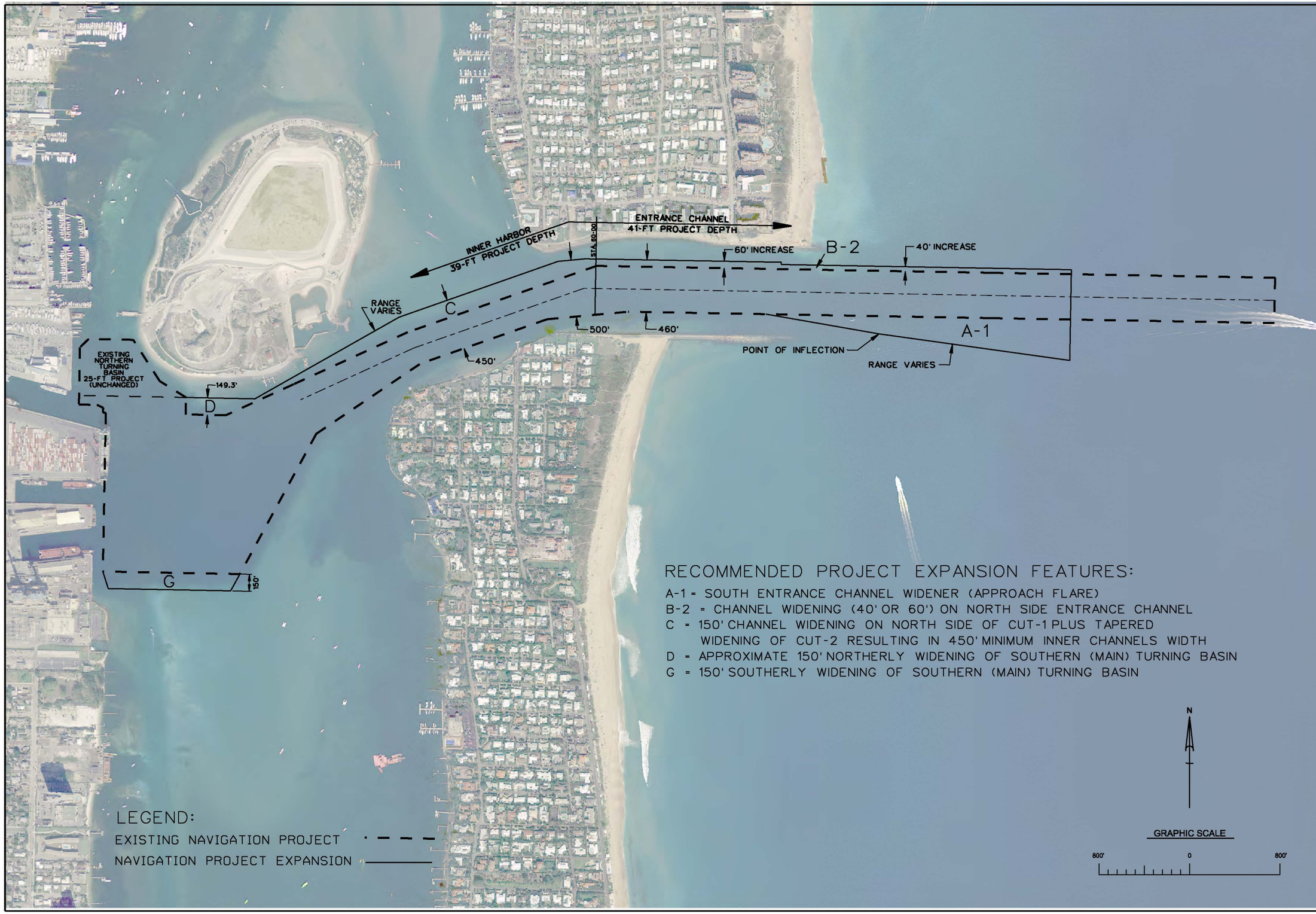
Reference files:

LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
NED PLAN
LOCATION AND VICINITY MAPS
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
1



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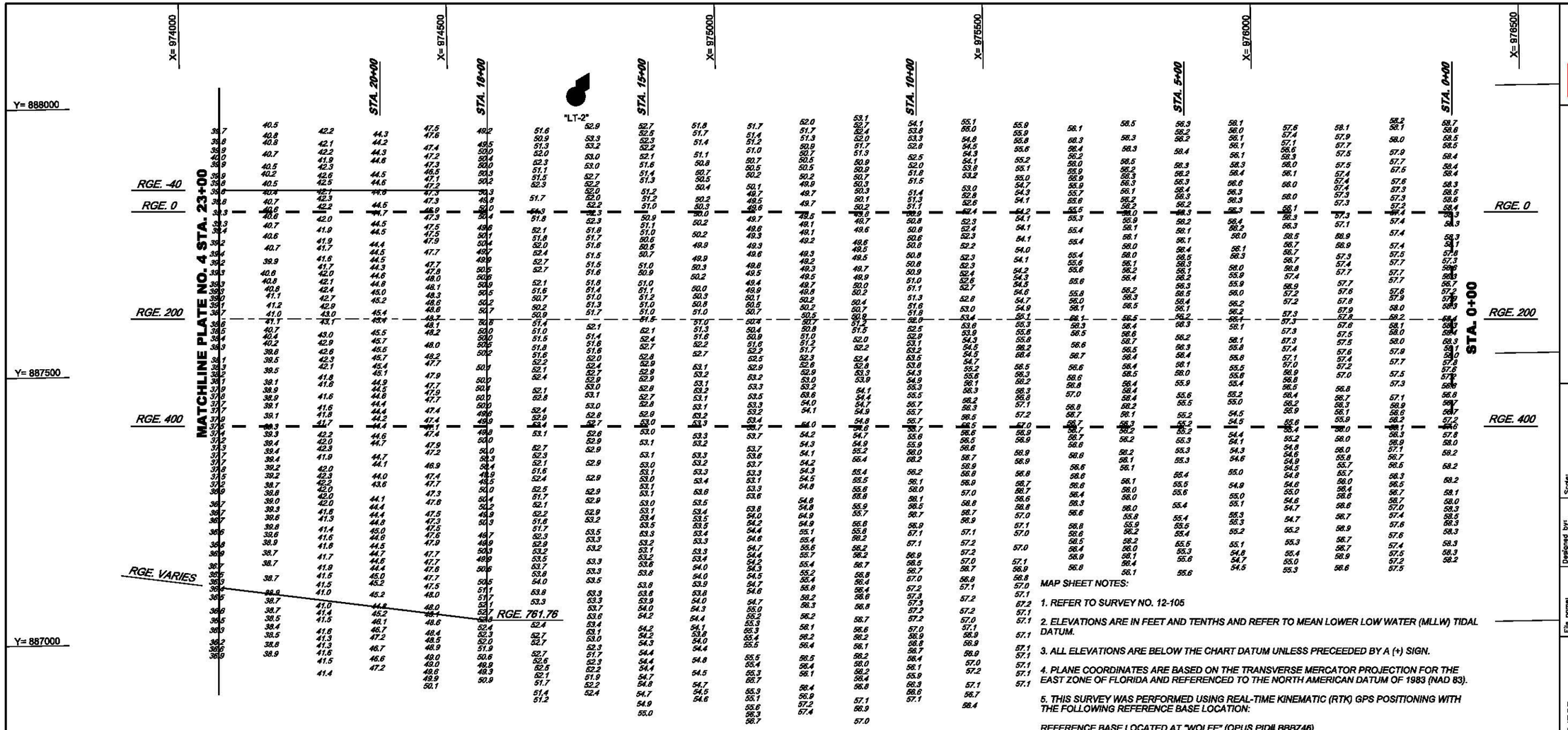
LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA

NED PLAN IMPROVEMENTS OVERVIEW

FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
2



ENTRANCE CHANNEL

AIDS TO NAVIGATION	PLANE COORDINATES	
	X	Y
LT. BUOY-2 (04/12)	974739.28	888007.95

EXISTING NAVIGATION PROJECT - - -

NAVIGATION PROJECT EXPANSION ———

NOTE: STATION AND RANGE VALUES ARE RELATIVE TO THE EXISTING PROJECT CONTROL.

N

GRAPHIC SCALE

200' 0 200'

MAP SHEET NOTES:

1. REFER TO SURVEY NO. 12-105
2. ELEVATIONS ARE IN FEET AND TENTHS AND REFER TO MEAN LOWER LOW WATER (MLLW) TIDAL DATUM.
3. ALL ELEVATIONS ARE BELOW THE CHART DATUM UNLESS PRECEEDED BY A (+) SIGN.
4. PLANE COORDINATES ARE BASED ON THE TRANSVERSE MERCATOR PROJECTION FOR THE EAST ZONE OF FLORIDA AND REFERENCED TO THE NORTH AMERICAN DATUM OF 1983 (NAD 83).
5. THIS SURVEY WAS PERFORMED USING REAL-TIME KINEMATIC (RTK) GPS POSITIONING WITH THE FOLLOWING REFERENCE BASE LOCATION:

   REFERENCE BASE LOCATED AT "WOLFE" (OPUS PID# BBBZ46)

   TIDE STAFF LOCATED FROM "A 310" (PID# AD2870)
6. DEPTHS DEPICTED BY THIS SURVEY ARE REFERENCED TO MLLW, TIDAL EPOCH 1983-2001, AS REPORTED BY THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA). NOAA'S VDATUM MODEL WAS USED AND CALIBRATED TO THE PUBLISHED MLLW HEIGHTS OF THE BEANCH MARKS ASSOCIATED WITH THE TIDE GAGE SITE SPECIFIED BELOW:

   NOAA TIDAL STATION 872-2588, PORT OF W. PALM BEACH, LAKE WORTH
7. VERTICAL MEASUREMENTS WERE MADE USING A ROSS SMART SOUNDER MODEL 835 WITH A SINGLE BEAM TRANSDUCER OPERATING AT 28 AND 200 kHz. SOUNDINGS SHOWN ARE IN HIGH FREQUENCY.

SURVEY VESSEL	DATE OF SURVEY	CUT
SB-32	24-25 APR 2012	ENT CH, CUT-1, CUT-2, TURNING BASIN

8. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED ABOVE AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS AT THAT TIME. THIS CHART IS SOLELY FOR THE DISTRIBUTION OF AVAILABLE DEPTHS AT THE TIME OF SURVEY.
9. SURVEY ACCURACY STANDARDS, QUALITY CONTROL, AND QUALITY ASSURANCE REQUIREMENTS WERE FOLLOWED DURING THIS SURVEY IN ACCORDANCE WITH USACE EM 1110-2-1003, HYDROGRAPHIC SURVEYING, 1 JAN 02.

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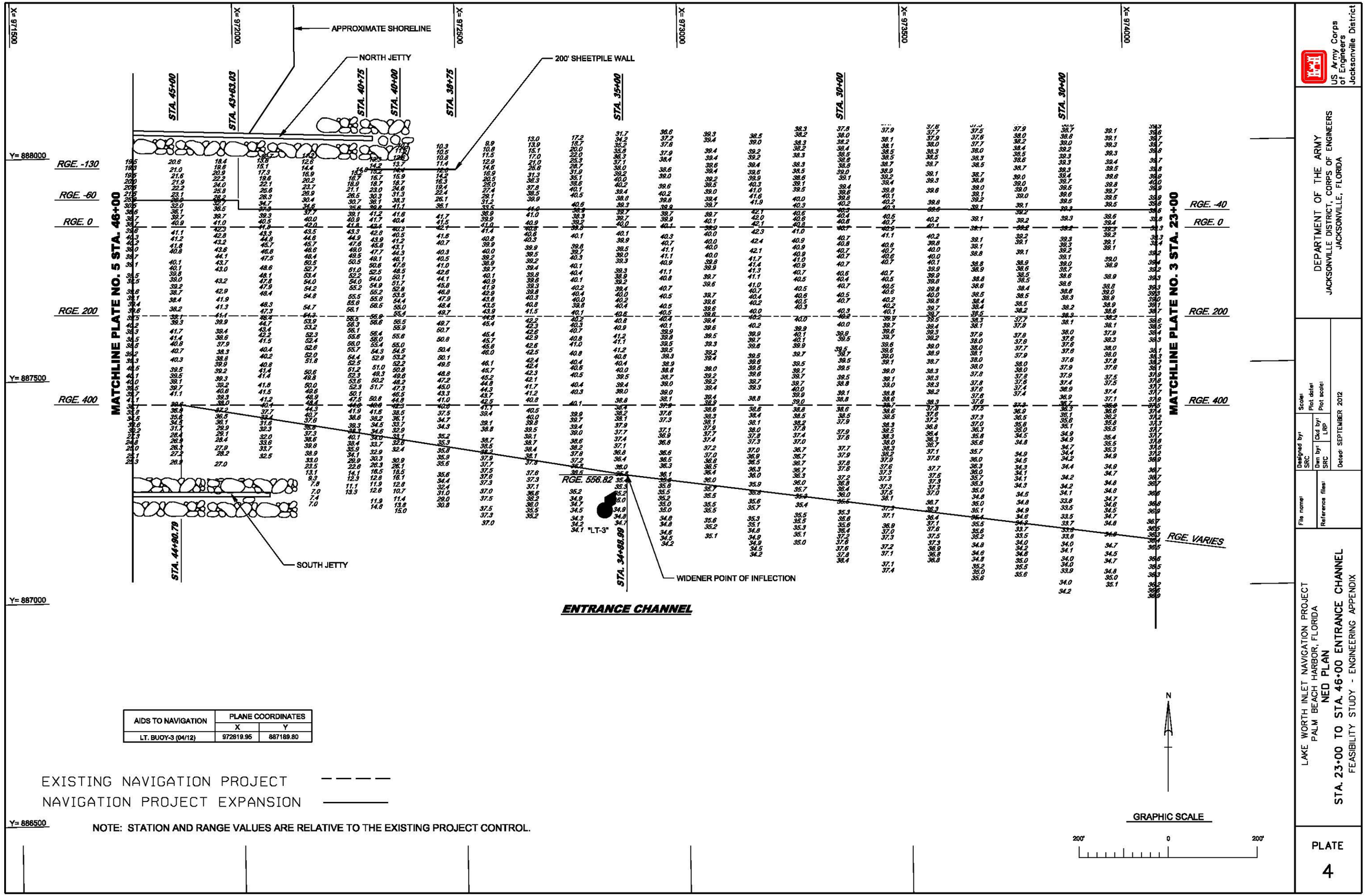
LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
NED PLAN
STA. 0+00 TO STA. 23+00 ENTRANCE CHANNEL
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
3



AIDS TO NAVIGATION	PLANE COORDINATES	
	X	Y
LT. BUOY-3 (04/12)	972819.95	887189.80

EXISTING NAVIGATION PROJECT — — — —

NAVIGATION PROJECT EXPANSION ————

NOTE: STATION AND RANGE VALUES ARE RELATIVE TO THE EXISTING PROJECT CONTROL.

N

GRAPHIC SCALE

200' 0 200'

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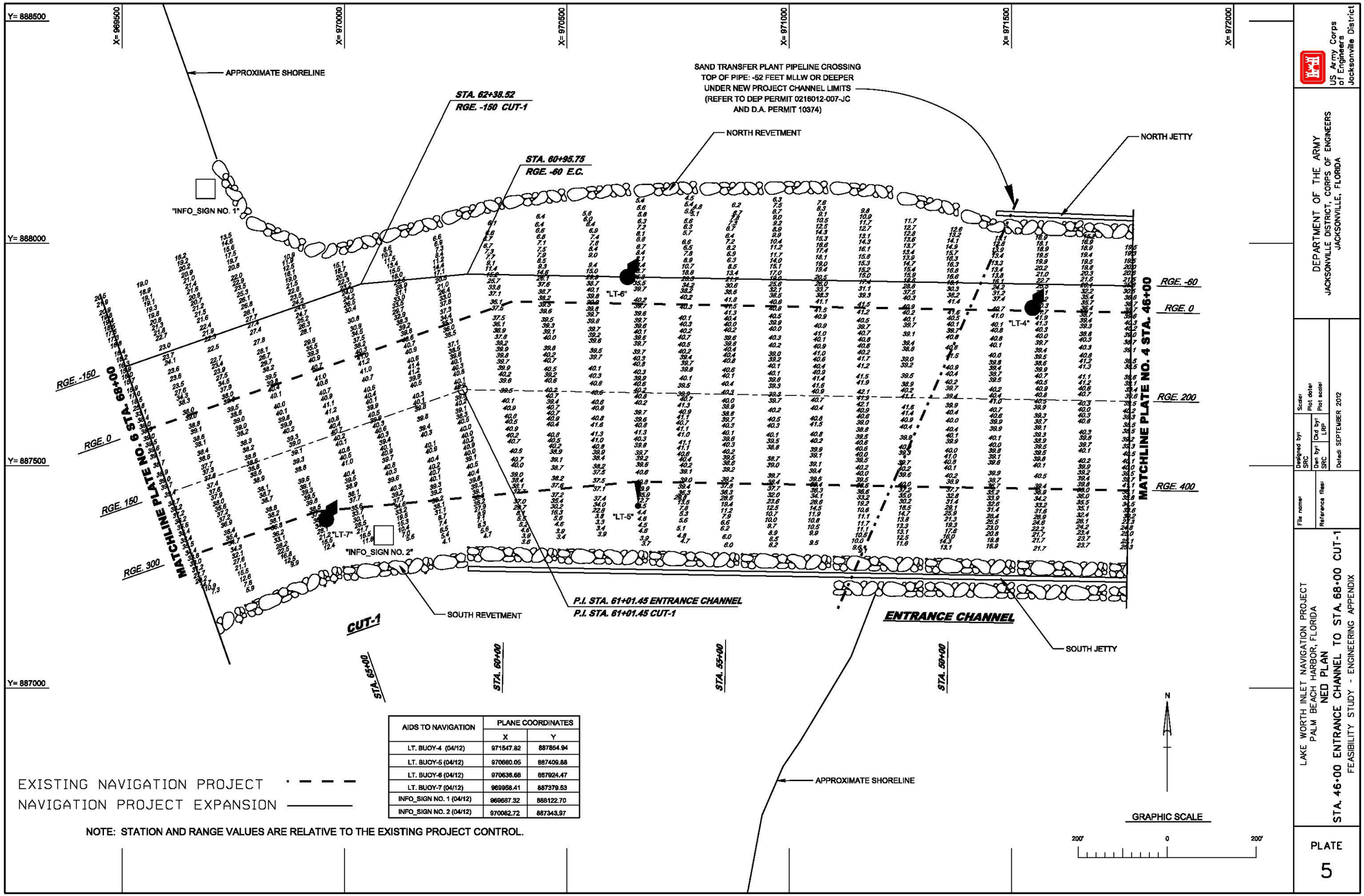
LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
NED PLAN
STA. 23+00 TO STA. 46+00 ENTRANCE CHANNEL
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
4



AIDS TO NAVIGATION	PLANE COORDINATES	
	X	Y
LT. BUOY-4 (04/12)	971547.82	887854.94
LT. BUOY-5 (04/12)	970660.05	887409.88
LT. BUOY-6 (04/12)	970636.68	887924.47
LT. BUOY-7 (04/12)	969958.41	887379.53
INFO_SIGN NO. 1 (04/12)	969687.32	888122.70
INFO_SIGN NO. 2 (04/12)	970082.72	887343.97

EXISTING NAVIGATION PROJECT - - - -

NAVIGATION PROJECT EXPANSION ———

NOTE: STATION AND RANGE VALUES ARE RELATIVE TO THE EXISTING PROJECT CONTROL.

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Reference files:

LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
NED PLAN
STA. 46+00 ENTRANCE CHANNEL TO STA. 68+00 CUT-1
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
5

X= 967000
X= 967500
X= 968000
X= 968500
X= 969000
X= 969500
Y= 887500
Y= 888000
Y= 887000
Y= 886500
Y= 886000

APPROXIMATE SHORELINE

P.I. STA. 87+92.96 CUT-2
P.I. STA. 0+00 TURNING BASIN

STA. 77+26.42 CUT-1
RGE. -150 CUT-1

P.I. STA. 76+93.27 CUT-1
P.I. STA. 76+93.27 CUT-2

RGE. VARIES
RGE. 0
RGE. 150
RGE. VARIES
RGE. -150
RGE. 0
RGE. 150
RGE. 300

"LT-10"
"LT-8"
"LT-9"
"LT-11"

MATCHLINE PLATE NO. 7 STA. 87+92.96 CUT-2

MATCHLINE PLATE NO. 5 STA. 68+00

CUT-1
CUT-2

SOUTH REVETMENT

STA. 85+00
STA. 80+00
STA. 70+00
STA. 70+00

APPROXIMATE SHORELINE

"DBN-2"

AIDS TO NAVIGATION	PLANE COORDINATES	
	X	Y
DBN - 2 (04/12)	968358.26	888044.86
LT. - 8 (04/12)	969322.01	887593.29
LT. - 9 (04/12)	968813.29	886931.80
LT. - 10 (04/12)	968208.11	887159.22
LT. - 11 (04/12)	967959.99	886307.78

EXISTING NAVIGATION PROJECT
NAVIGATION PROJECT EXPANSION

NOTE: STATION AND RANGE VALUES ARE RELATIVE TO THE EXISTING PROJECT CONTROL.

N

GRAPHIC SCALE
200' 0 200'

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Scale:
Plot date:
Plot scale:
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Drawn by: SRC
Checked by: LRP
Dated: SEPTEMBER 2012
File name:
Reference files:

LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
NED PLAN
STA. 68+00 CUT-1 TO STA. 87+92.96 CUT-2
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
6

X= 965500
X= 966000
X= 966500
X= 967000
X= 967500
X= 968000

Y= 887500
Y= 887000
Y= 886500
Y= 886000

APPROXIMATE SHORELINE

NORTHERN TURNING BASIN

PORT SLIP 1

SOUTHERN TURNING BASIN

APPROXIMATE SHORELINE

PORT OF
PALM BEACH

PEANUT ISLAND

P.I. STA. 87+92.96 CUT-2
P.I. STA. 0+00 TURNING BASIN

APPROXIMATE SHORELINE

X-966750.38
Y-886706.73

"INFO_SIGN"

"LT-12"

X-967358.01
Y-886695.07

RGE. VARIES

RGE. VARIES

MATCHLINE PLATE NO. 6 STA. 87+92.96 CUT-2

RGE. VARIES

RGE. VARIES

RGE. VARIES

MATCHLINE PLATE NO. 8 SOUTHERN TURNING BASIN

EXISTING NAVIGATION PROJECT

NAVIGATION PROJECT EXPANSION

NOTE: STATION AND RANGE VALUES ARE RELATIVE TO THE EXISTING PROJECT CONTROL.

AIDS TO NAVIGATION	PLANE COORDINATES	
	X	Y
LT. - 12 (04/12)	967959.99	886307.78
INFO SIGN (04/12)	968899.52	886714.27

N

GRAPHIC SCALE

200' 0 200'

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LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
NED PLAN
NORTHERN AND SOUTHERN TURNING BASINS
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
7

MATCHLINE PLATE NO. 7 SOUTHERN TURNING BASIN

X= 965500 | X= 966000 | X= 966500 | X= 967000 | X= 967500 | X= 968000

Y= 886000

APPROXIMATE SHORELINE

RGE. VARIES

PORT SLIP 2

PORT OF PALM BEACH

SOUTHERN TURNING BASIN

Y= 885500

PORT SLIP 3

Y= 885000

"DBN-2"

"LT-1"

"LT-13"

X-966063.51
Y-885020.30

X-967144.48
Y-884999.55

APPROXIMATE SHORELINE

Y= 884500

EXISTING NAVIGATION PROJECT

NAVIGATION PROJECT EXPANSION

NOTE: STATION AND RANGE VALUES ARE RELATIVE TO THE EXISTING PROJECT CONTROL.

AIDS TO NAVIGATION	PLANE COORDINATES	
	X	Y
LT. - 1 (04/12)	966417.04	885021.35
DBN - 2 (04/12)	966260.86	884944.39
LT. - 13 (04/12)	967275.12	885039.51

N

GRAPHIC SCALE

200' 0 200'

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LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
NED PLAN
SOUTHERN TURNING BASIN
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
8

RGE. -800

STA. 37+50

STA. 32+00

STA. 37+00

RGE. -300

RGE. -100

RGE. -50

STA. 47+00

STA. 40+50

STA. 30+00

RGE. 00

RGE. 200

RGE. 400

EXPANDED SETTLING BASIN

EXTENDED SETTLING BASIN

SETTLING BASIN

Currently Maintained Depths
Settling Basin - 35' Required + 2' Allowable
Extended Settling Basin - 35' Required + 2' Allowable
Expanded Settling Basin - 35' Required + 2' Allowable

ADVANCE MAINTENANCE ZONE = 4 FEET
(STATION 30+00 TO STATION 47+00; RANGE 00 TO RANGE 400)
(Currently Maintained Depth = 39' Required + 2' Allowable Overdepth)

ENTRANCE CHANNEL

N

GRAPHIC SCALE

200' 0 200'

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Dated: SEPTEMBER 2012

File name:

Reference files:

LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA

EXISTING PROJECT - ADVANCE MAINTENANCE AND SETTLING BASIN PLAN

FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
9

PROPOSED PROJECT SETTLING BASIN DEPTHS
AREA SB1 = 51' Required + 1' Allowable Overdepth
AREA SB2 = 34' Required + 1' Allowable Overdepth
AREA SB3 = 26' Required + 1' Allowable Overdepth

RGE. -800
STA. 39+75
STA. 38+00
STA. 37+50
STA. 34+00
AREA SB3
AREA SB2
AREA SB1
RGE. -350
STA. 47+00
STA. 44+00
STA. 40+75
STA. 38+75
RGE. -130
SHEETPILE WALL
RGE. -60
RGE. 00
AMZ-C
= 8 Feet
STA. 30+00
RGE. -40
RGE. 00
RGE. 125
STA. 40+50
STA. 39+00
AMZ-B = 4 Feet
ADVANCE MAINTENANCE ZONE A (AMZ-A) = 8 feet
(Sta. 30+00 to Sta. 39+00; Full Channel Width)
RGE. 400
RGE. 400
ENTRANCE CHANNEL

PROPOSED NED PLAN PLUS ADVANCE MAINTENANCE DEPTHS
ZONE A = 51' Required + 1' Allowable Overdepth
ZONE B = 47' Required + 1' Allowable Overdepth
ZONE C = 51' Required + 1' Allowable Overdepth

NOTE: STATION AND RANGE VALUES ARE RELATIVE TO THE EXISTING PROJECT CHANNEL

GRAPHIC SCALE
200' 0 200'

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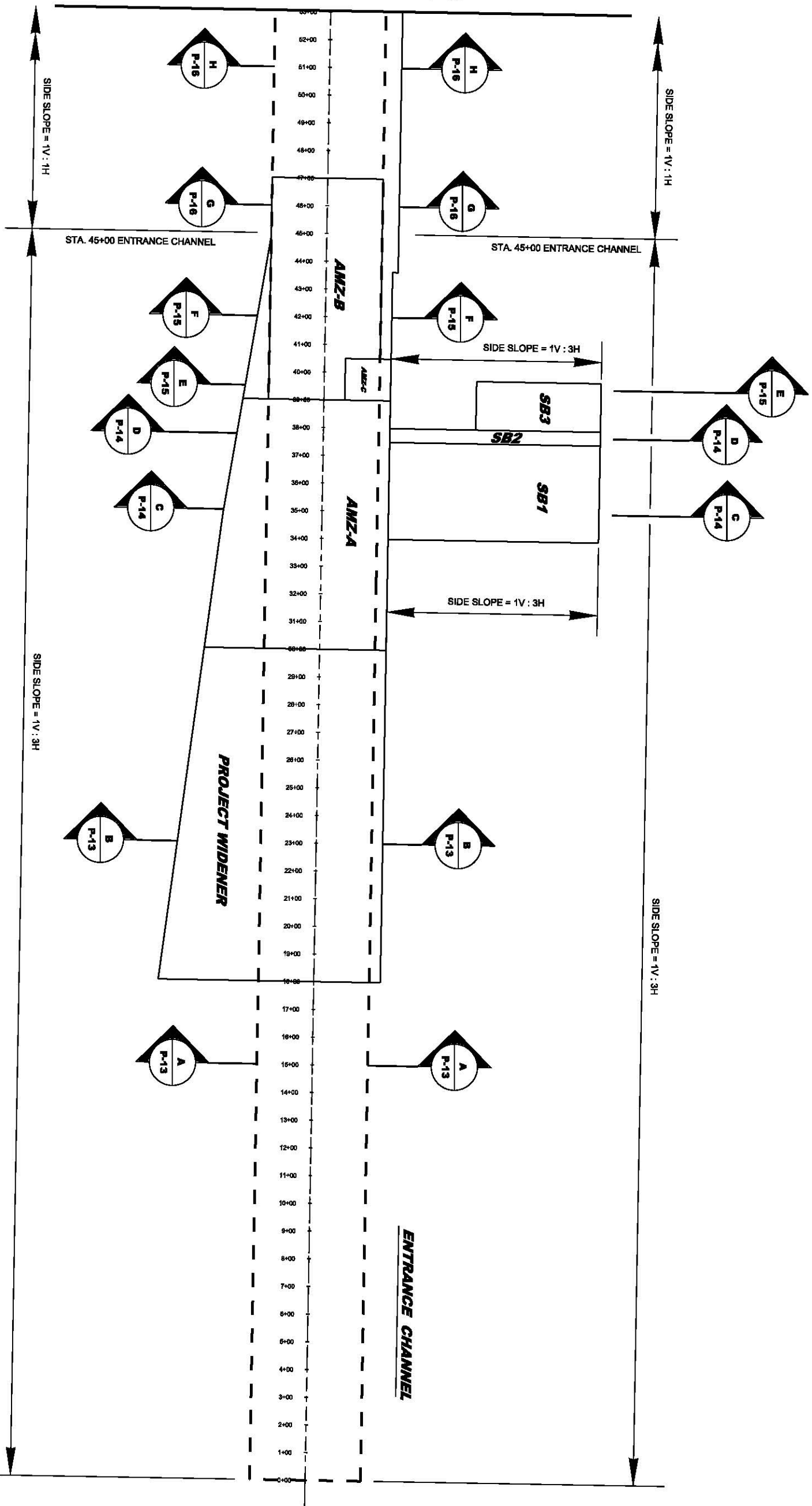
LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
PROPOSED PROJECT - ADVANCE MAINTENANCE AND SETTLING BASIN PLAN
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
10

MATCHLINE PLATE 10 STA. 53+00



LEGEND:

EXISTING NAVIGATION PROJECT — — —

NAVIGATION PROJECT EXPANSION ———

NOTE: STATION AND RANGE VALUES ARE RELATIVE TO THE EXISTING PROJECT CONTROL.

PLATE 11

LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
SIDE SLOPE PLAN
AND TYPICAL DREDGING SECTIONS
FEASIBILITY STUDY - ENGINEERING APPENDIX

File name:
Reference files:

Designed by: SRC
Dwn by: SRC MRZ
Ckd by: LRP
Scale:
Plot date:
Plot scale:
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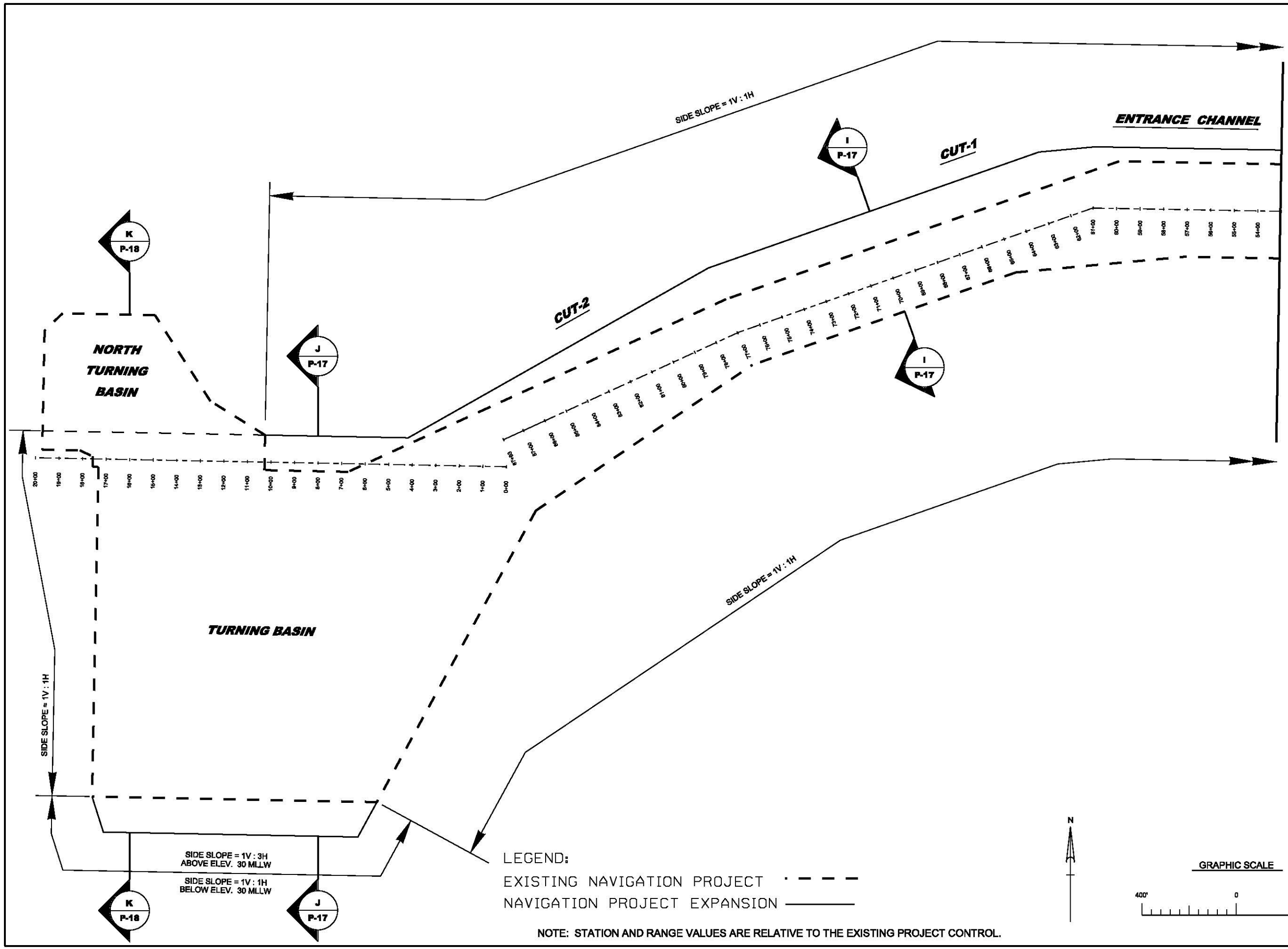
US Army Corps of Engineers
Jacksonville District



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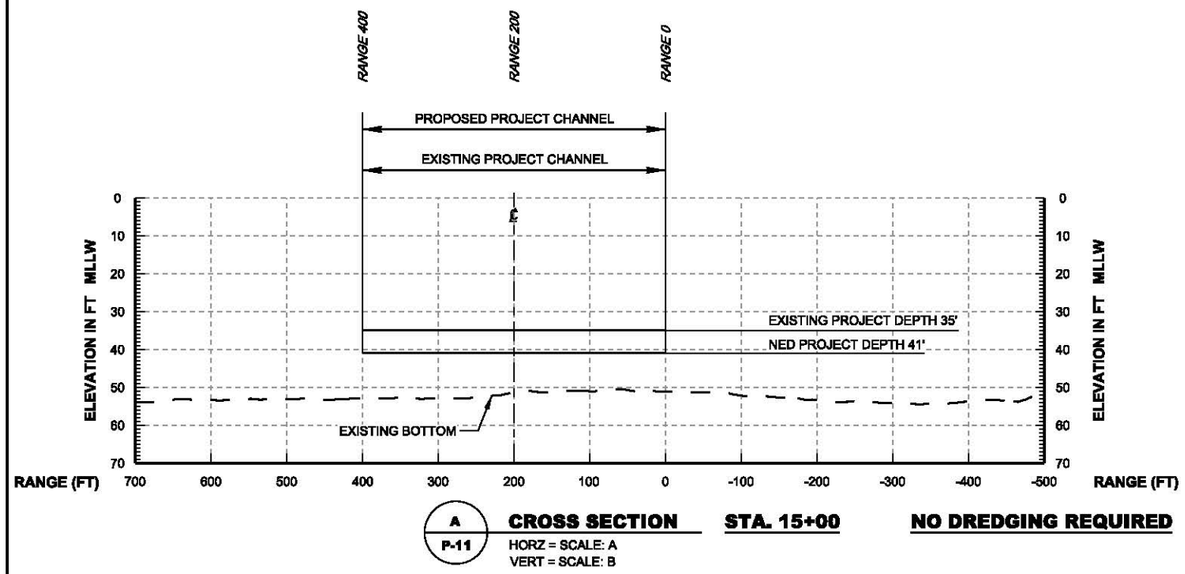
Drawn by: SRC | Ckd by: LRP | Plot date: | Plot scale:
Dated: SEPTEMBER 2012

File name:
Reference files:

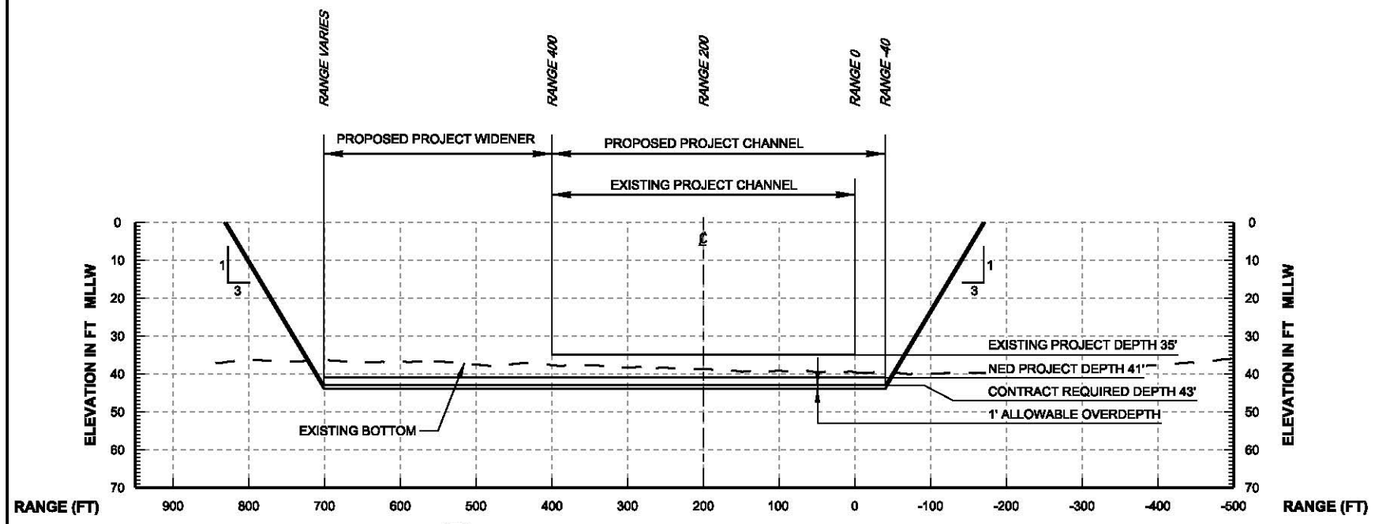
LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
SIDE SLOPE PLAN
AND TYPICAL DREDGING SECTIONS
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
12



A / P-11 **CROSS SECTION** **STA. 15+00** **NO DREDGING REQUIRED**

HORZ = SCALE: A
VERT = SCALE: B



B / P-11 **CROSS SECTION** **STA. 23+00**

HORZ = SCALE: A
VERT = SCALE: B

GRAPHIC SCALES

"A" 200' 0 200'

"B" 40' 0 40'

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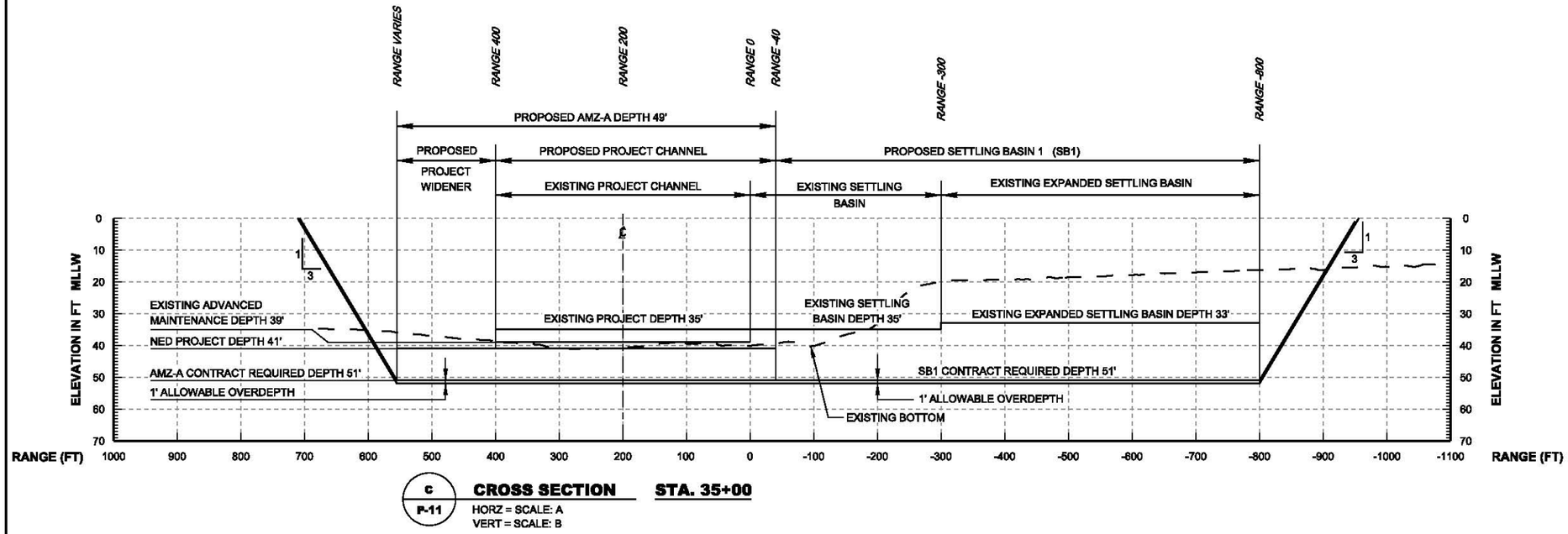
Checked by: LRP
Dated: SEPTEMBER 2012
Scale:
Plot date:
Plot scale:
File name:
Reference files:

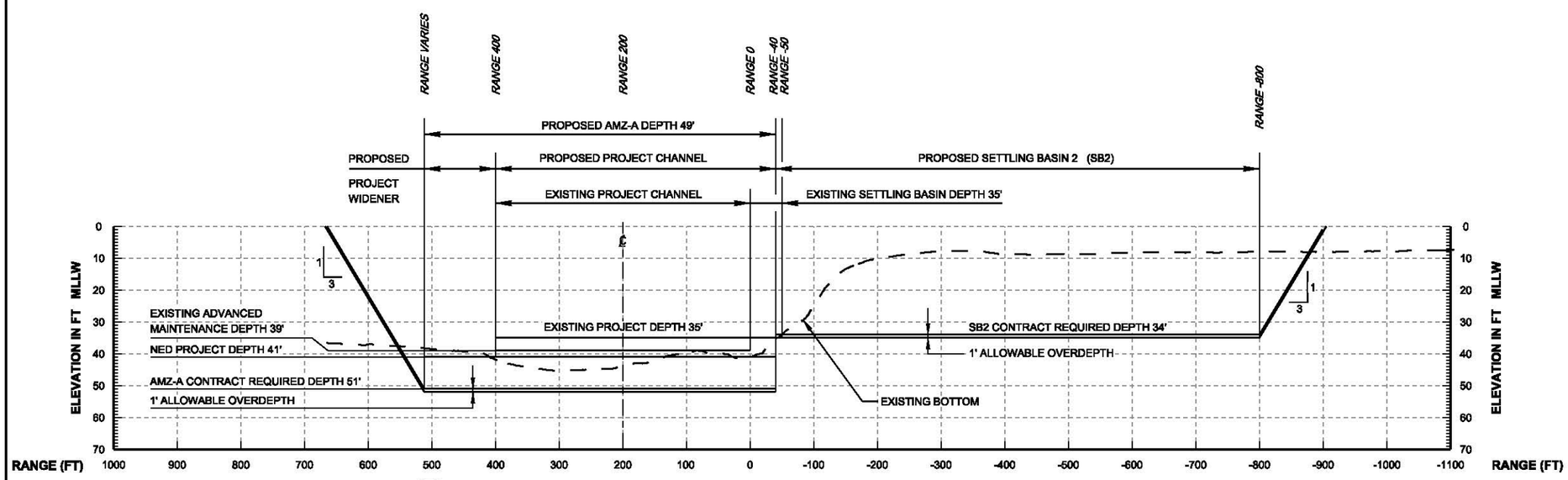
LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
TYPICAL DREDGING SECTIONS
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
13



C / F-11 **CROSS SECTION** **STA. 35+00**

HORZ = SCALE: A
VERT = SCALE: B



D / F-11 **CROSS SECTION** **STA. 37+75**

HORZ = SCALE: A
VERT = SCALE: B

GRAPHIC SCALES

"A" 200' 0 200'

"B" 40' 0 40'

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JACKSONVILLE, FLORIDA

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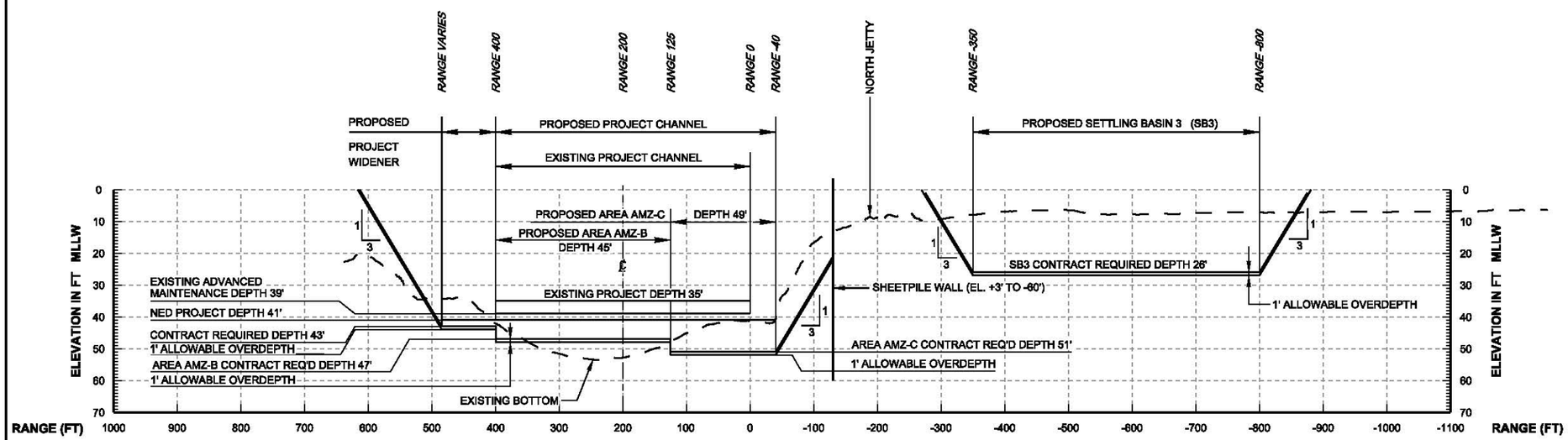
File name: | Reference files:

LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA

TYPICAL DREDGING SECTIONS

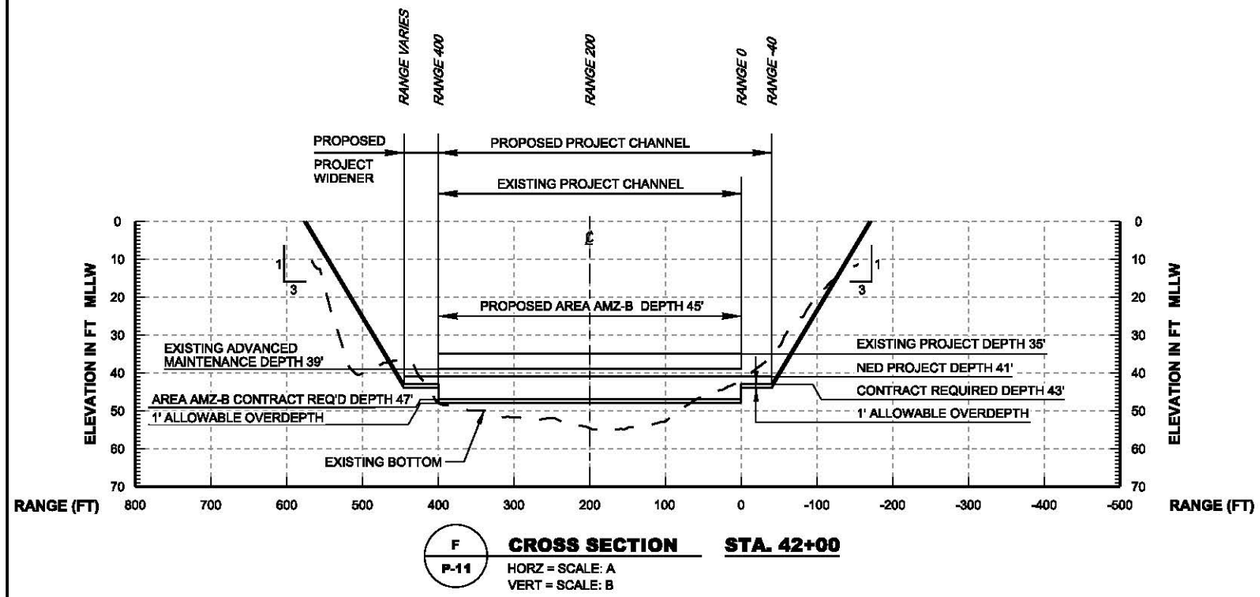
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
14



E / P-11 **CROSS SECTION** **STA. 39+50**

HORZ = SCALE: A
VERT = SCALE: B



F / P-11 **CROSS SECTION** **STA. 42+00**

HORZ = SCALE: A
VERT = SCALE: B

GRAPHIC SCALES

"A" 200' 0 200'

"B" 40' 0 40'

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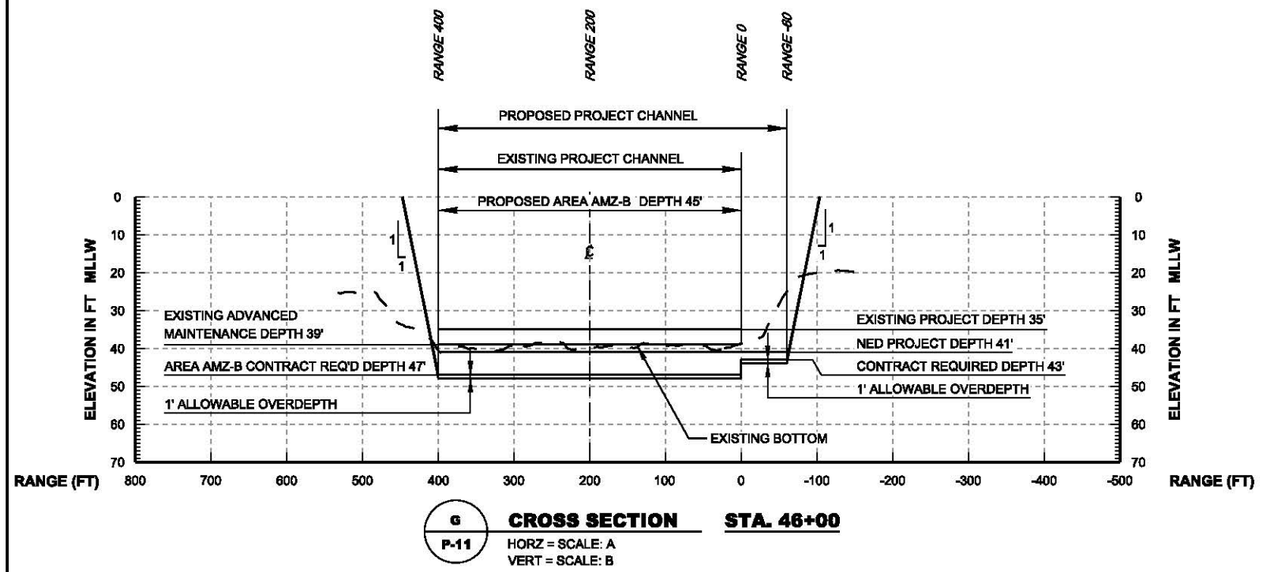
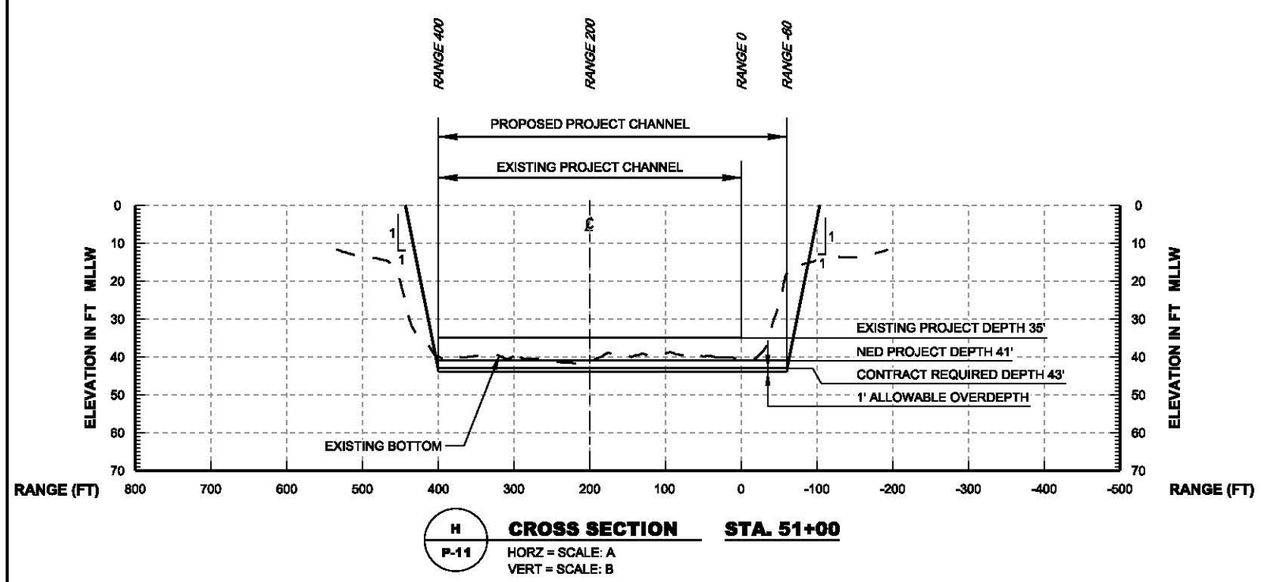
LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
TYPICAL DREDGING SECTIONS
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
15



G / P-11 **CROSS SECTION** **STA. 46+00**

HORZ = SCALE: A
VERT = SCALE: B



H / P-11 **CROSS SECTION** **STA. 51+00**

HORZ = SCALE: A
VERT = SCALE: B

GRAPHIC SCALES

"A" 200' 0 200'

"B" 40' 0 40'

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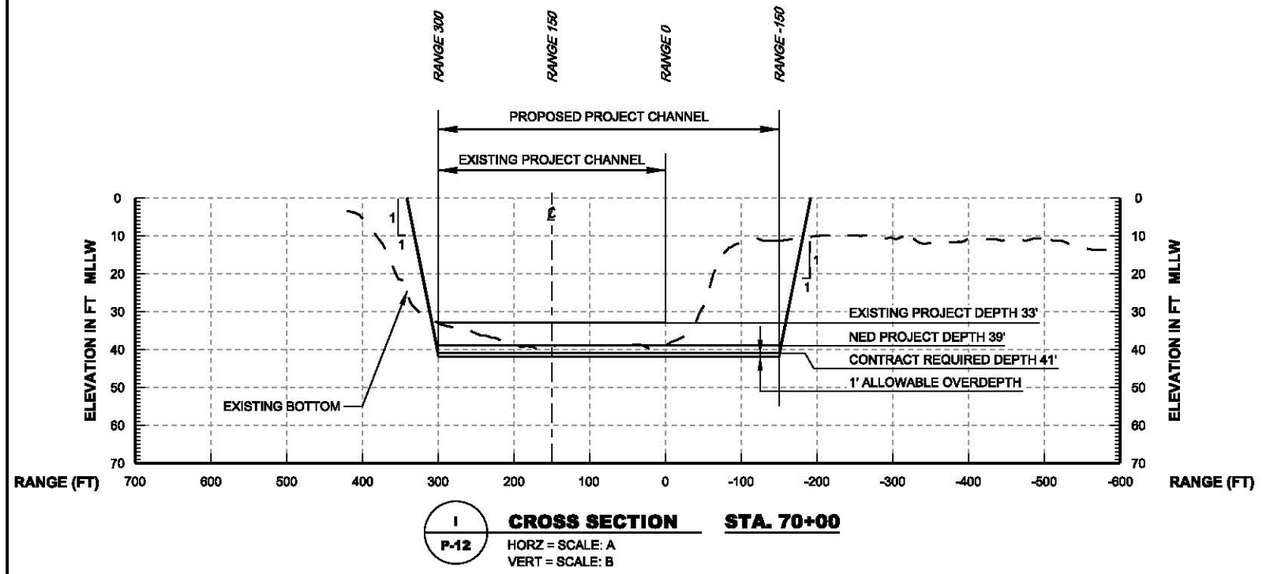
LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA

TYPICAL DREDGING SECTIONS

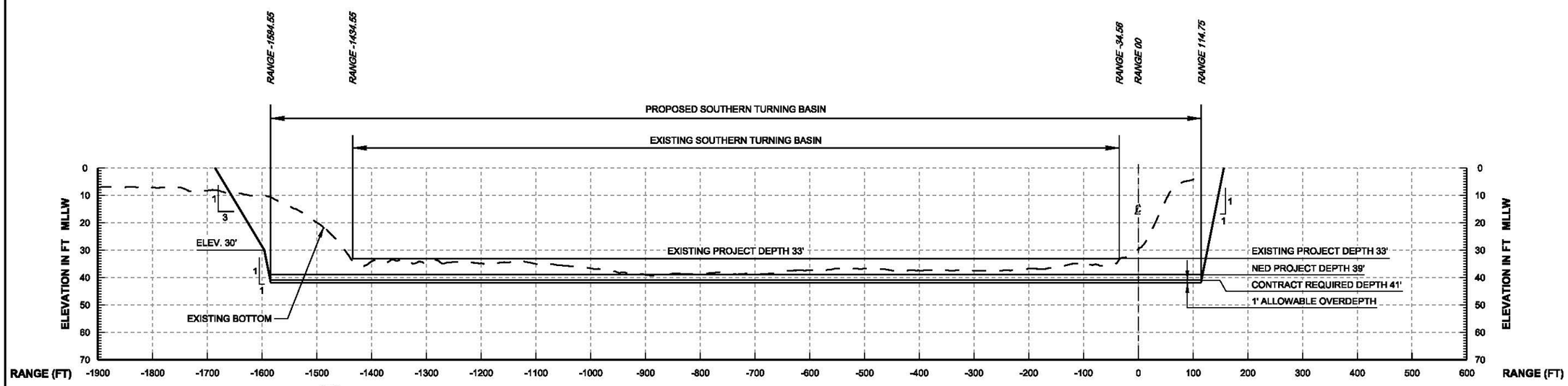
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
16



I / P-12 **CROSS SECTION** **STA. 70+00**

HORZ = SCALE: A
VERT = SCALE: B



J / P-12 **CROSS SECTION** **STA. 8+00**

HORZ = SCALE: A
VERT = SCALE: B

GRAPHIC SCALES

"A" 200' 0 200'

"B" 40' 0 40'

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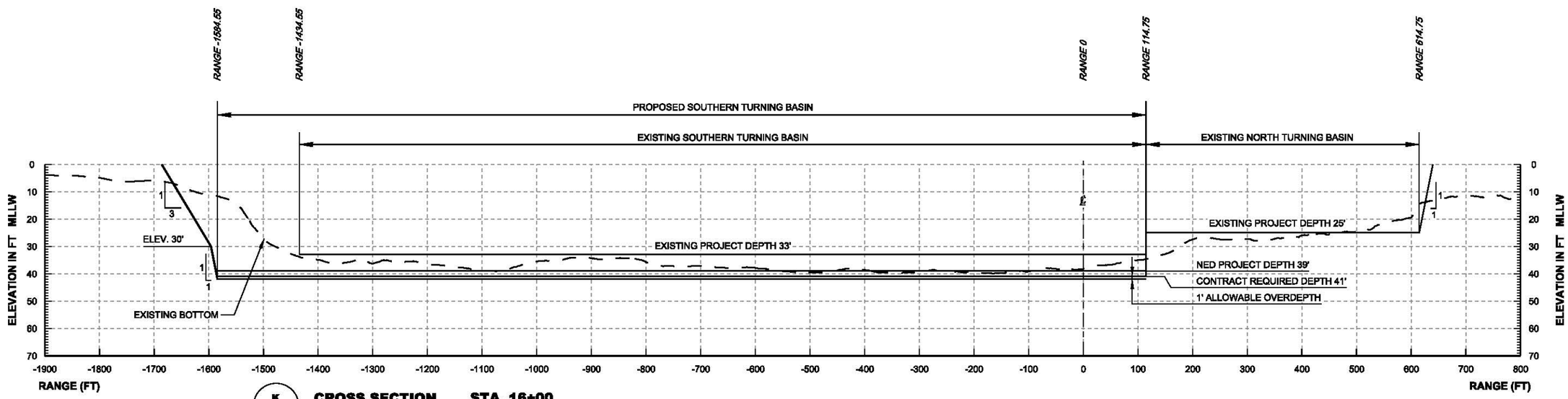
LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA

TYPICAL DREDGING SECTIONS

FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
17



K / P-12 **CROSS SECTION** **STA. 16+00**

HORZ = SCALE: A
VERT = SCALE: B

GRAPHIC SCALES

"A" 200' 0 200'

"B" 40' 0 40'

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Reference files:

LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA

TYPICAL DREDGING SECTIONS

FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
18

LAKE WORTH INLET

ATLANTIC OCEAN

LAKE WORTH

X=968,000
X=969,000
X=970,000
X=971,000
X=972,000
X=973,000
X=974,000
X=975,000

Y=887,000
Y=886,000
Y=885,000
Y=884,000
Y=883,000
Y=882,000

R-76
R-76.5
R-77
R-77.5
R-78
R-79
R-80
R-81

500'

TOWN OF
PALM BEACH

L
P-20

EXISTING
NEARSHORE
DISPOSAL AREA

19.36' NAVD88 CONTOUR

EXISTING BEACH
DISPOSAL AREA
(APPROX. 2900')

PROPOSED EXPANDED
BEACH DISPOSAL AREA
(APPROX. 2000')

N

GRAPHIC SCALE
600' 0 600'

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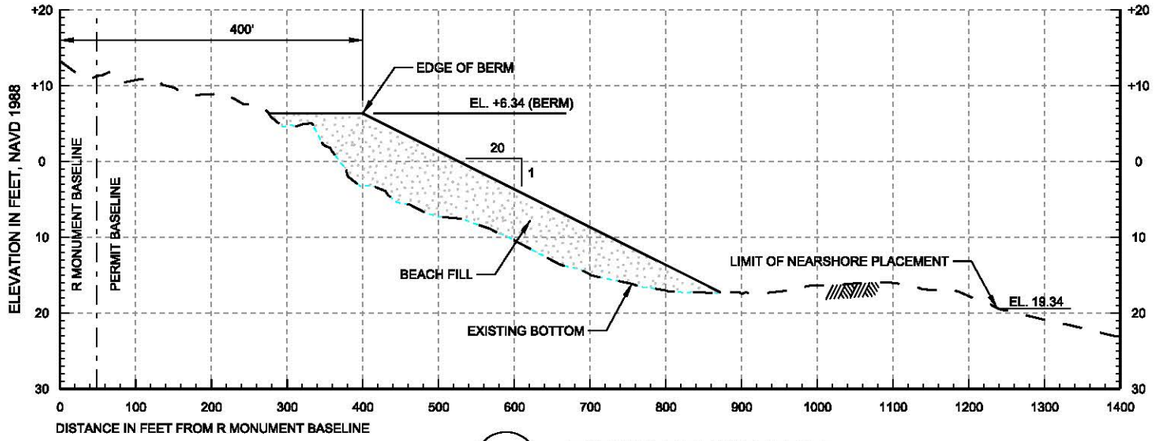
Checked by: LRP
Dated: SEPTEMBER 2012
Scale:
Plot date:
Plot scale:
File name:
Reference files:

LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
BEACH/NEARSHORE DISPOSAL PLAN
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
19



L
P-19

TYPICAL BEACH PROFILE

SCALE: A (HORZ)
SCALE: B (VERT)

GRAPHIC SCALES

"A" 200' 0 200'

"B" 20' 0 20'

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LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
TYPICAL BEACH DISPOSAL SECTION
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
20

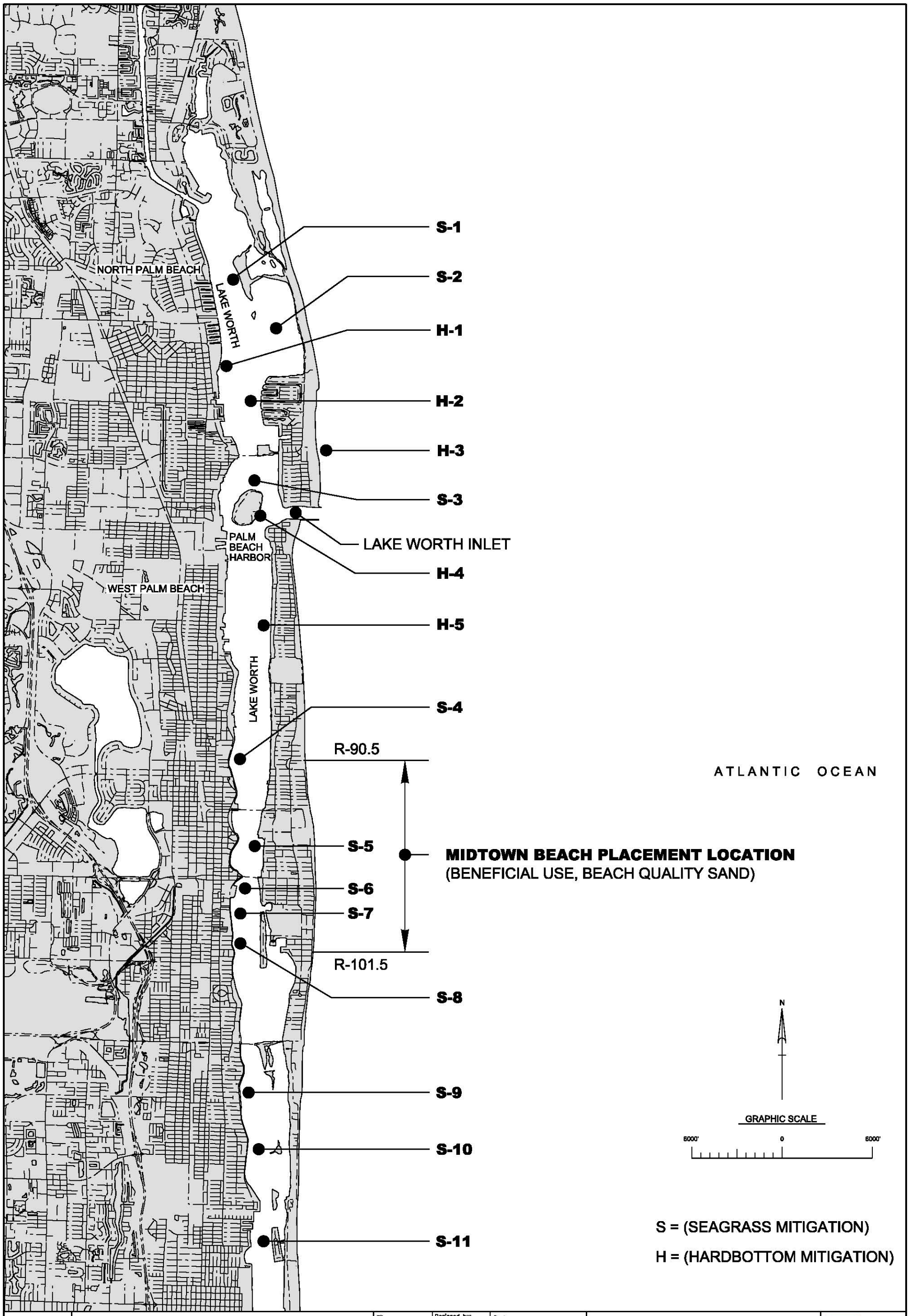

PLATE 21

LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA

PROPOSED POTENTIAL MITIGATION / BENEFICIAL USE SITES

FEASIBILITY STUDY - ENGINEERING APPENDIX

File name:
Reference files:

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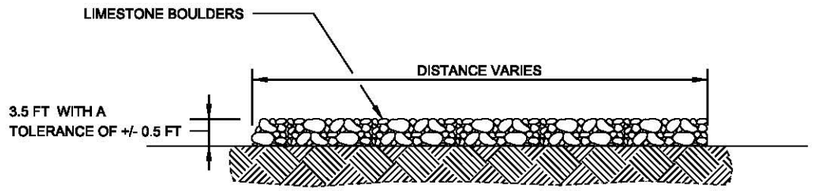
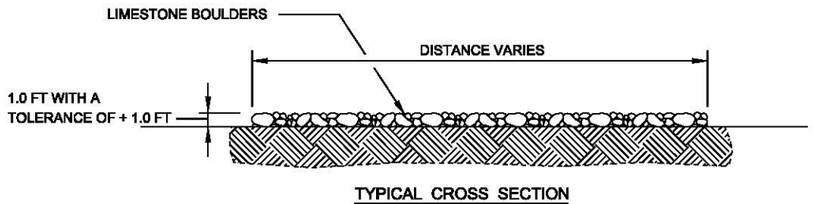


TYPICAL CROSS SECTION

HIGH-RELIEF, HIGH COMPLEXITY HARDBOTTOM MITIGATION SECTION

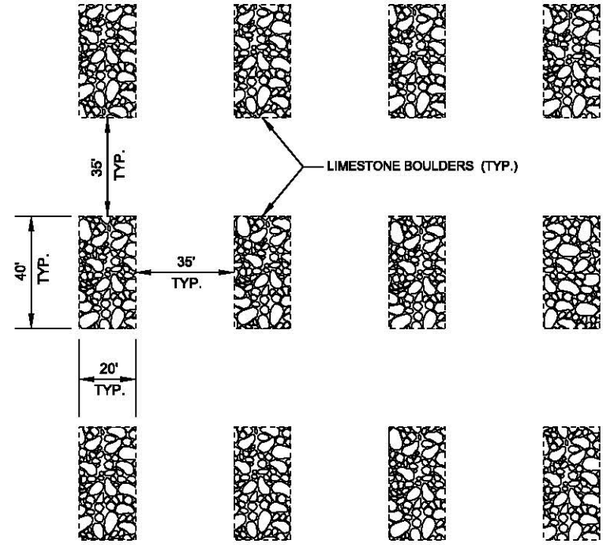
N.T.S.



TYPICAL CROSS SECTION

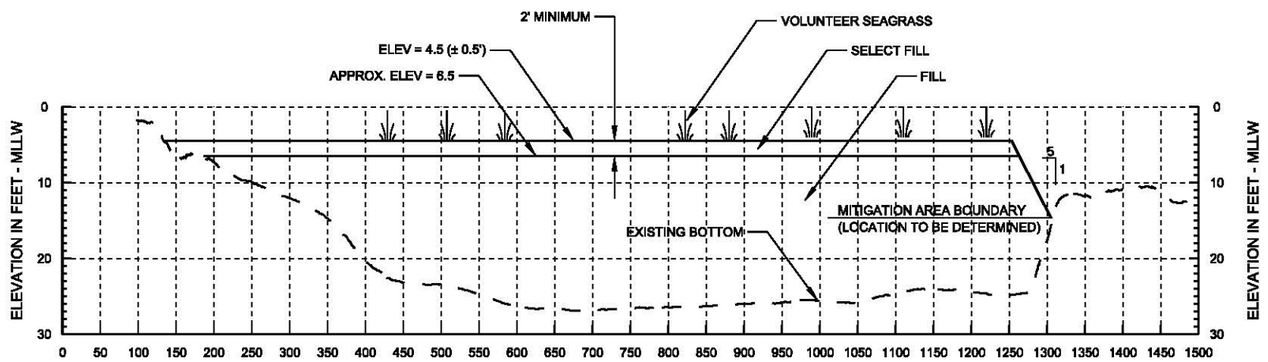
LOW-RELIEF, LOW COMPLEXITY HARDBOTTOM MITIGATION SECTION

N.T.S.



HIGH-RELIEF, HIGH COMPLEXITY HARDBOTTOM MITIGATION PLAN

N.T.S.



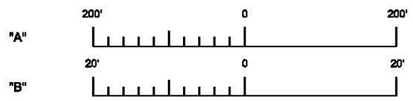
TYPICAL CROSS SECTION SEAGRASS MITIGATION AREA

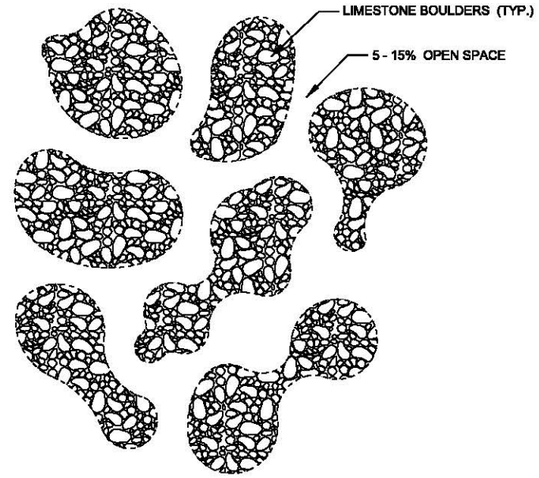
HORZ = SCALE: A
VERT = SCALE: B

NOTE:

DESIGN IS CONCEPTUAL, ELEVATIONS AND OTHER PARAMETERS ARE SUBJECT TO MODIFICATION.

GRAPHIC SCALES





LOW-RELIEF, LOW COMPLEXITY HARDBOTTOM MITIGATION PLAN

N.T.S.

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LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA

TYPICAL CROSS SECTIONS - SEAGRASS AND HARDBOTTOM MITIGATION AND HARDBOTTOM MITIGATION PLAN

FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
22

X=970,000
X=975,000
X=980,000
X=985,000
X=990,000
X=995,000
X=1,000,000
X=1,005,000
Y=900,000
Y=895,000
Y=890,000
Y=885,000
Y=880,000
Y=875,000
BLDG (TALLEST OF SIX)
6s 53ft
Fl 2.5s 19ft
R "2" Fl R 2.5s
G "3" Fl G 4s
(use inset)
Spoil
Dump Site
Discontinued Spoil Area
Lake Worth Inlet
RW "LW" Mo (A)
TERRITORIAL SEA
Obstn Fish Haven (auth min 50 ft)
Obstn Fish Haven
Obstn Fish Haven (auth min 50 ft)
Obstn Fish Haven (auth min 50 ft)
Obstn Fish Haven
Obstn Fish Haven (auth min 50 ft)
High Speed Ferry Route (see note H)
ANCHORAGE AREA 110.185 (see note A)
(see note X)
LIMITS OF ODMDS
LIMITS OF RELEASE ZONE
APPROXIMATELY 4.4 NAUTICAL MILES TO CENTER OF ODMDS RELEASE ZONE
Dump Site (dredged material) (see note S)
PA
Depths from survey of 1964
ATLANTIC OCEAN
S Co
S Co Sh
S Sh
S Co
S Sh
S Co
S Cy
h Co
S G
Shl rej (1996) ED
rky
Wk
GRAPHIC SCALE
3000' 0 3000'
N

NOTE:
INFORMATION SHOWN OBTAINED FROM NOAA NAVIGATION CHART 11466
SOUNDINGS IN FEET, MEAN LOWER LOW WATER (MLLW).

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Plot scale:
Dated: SEPTEMBER 2012
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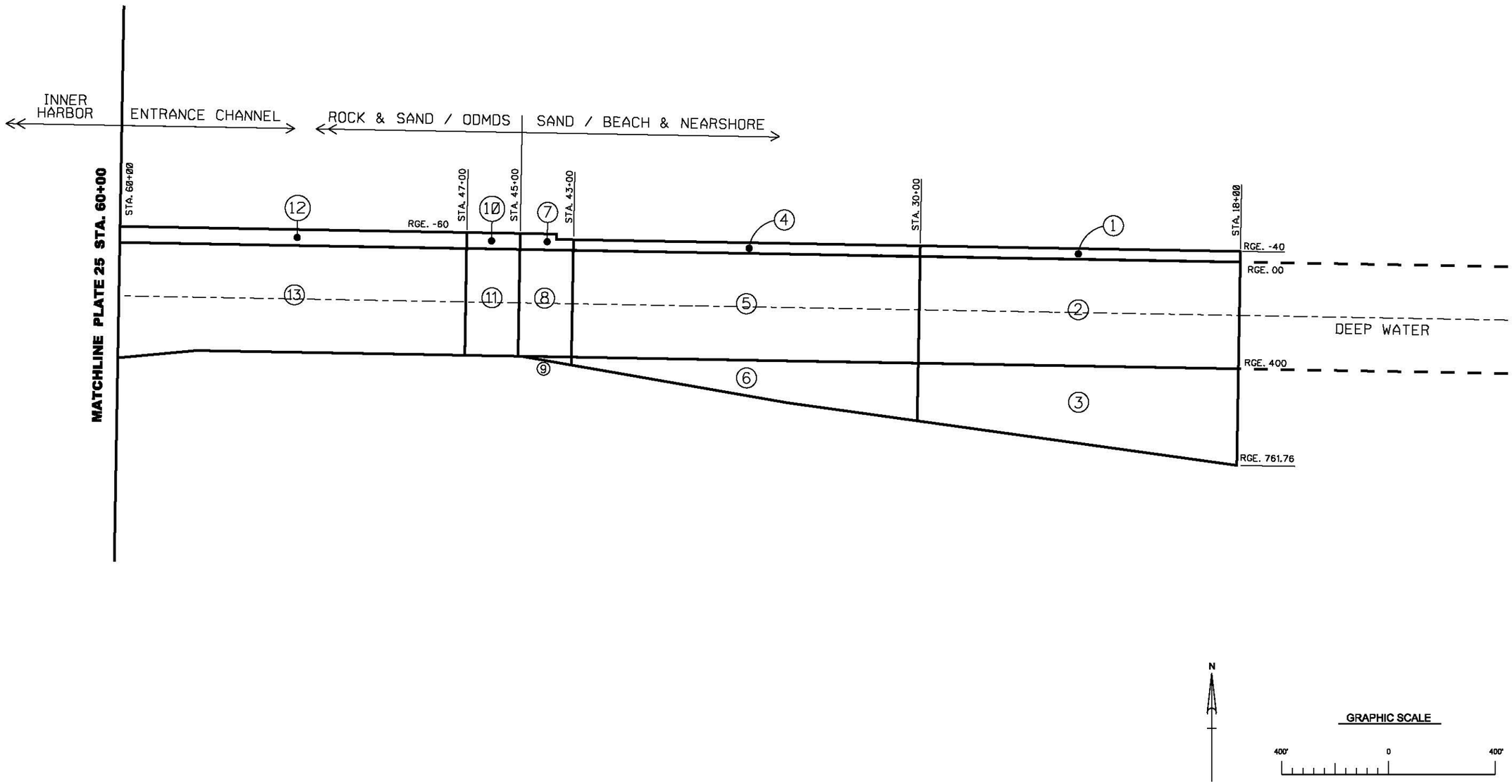
Reference files:

LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA
ODMDS PLAN
FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
23



NOTE: STATION AND RANGE VALUES ARE RELATIVE TO THE EXISTING PROJECT CONTROL.

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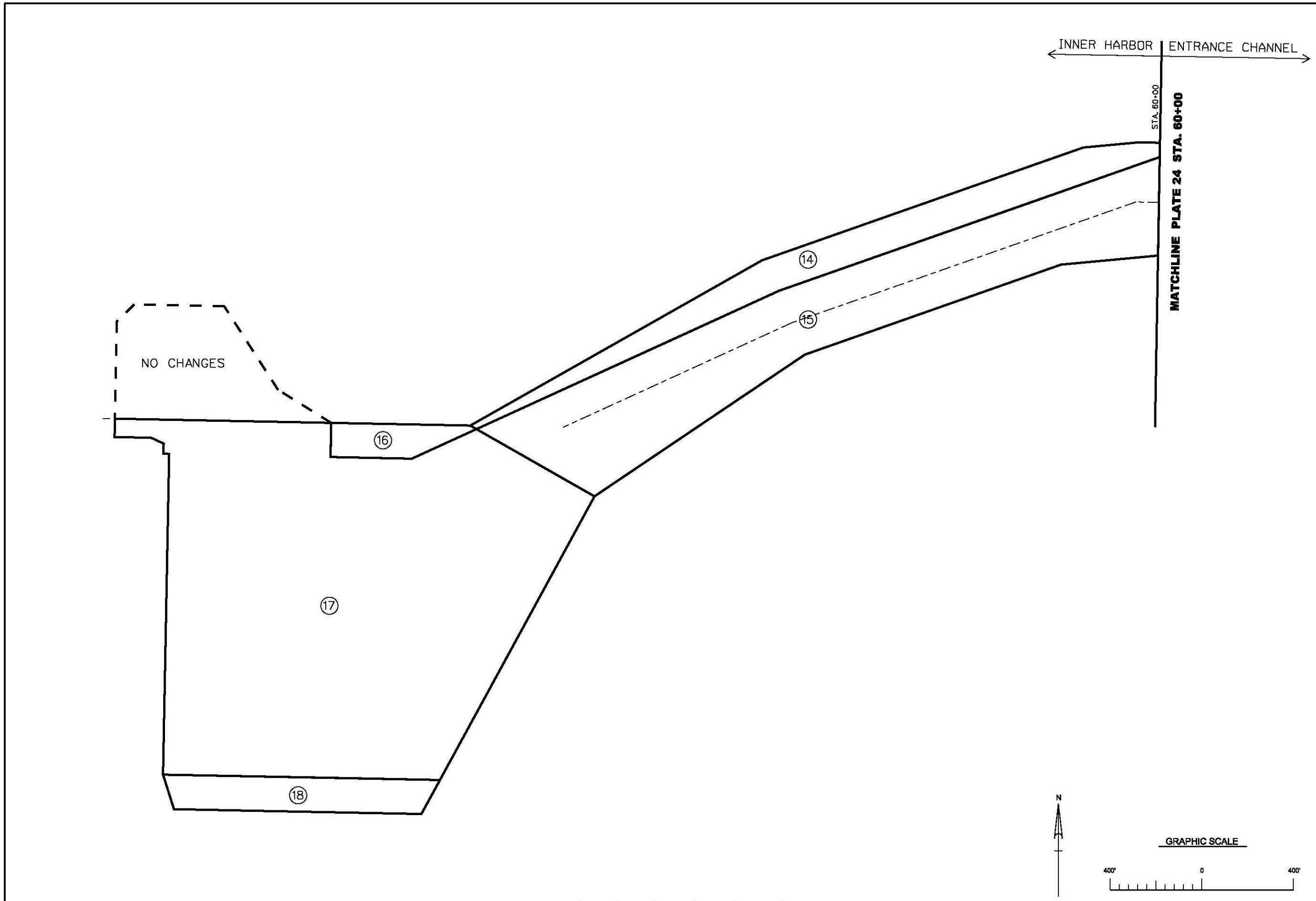
PALM BEACH HARBOR, FLORIDA

NED PLAN

AREA BREAKDOWN FOR VOLUMETRIC AND COST ANALYSIS

FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
24



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Reference files:

LAKE WORTH INLET NAVIGATION PROJECT
PALM BEACH HARBOR, FLORIDA

NED PLAN

AREA BREAKDOWN FOR VOLUMETRIC AND COST ANALYSIS

FEASIBILITY STUDY - ENGINEERING APPENDIX

PLATE
25